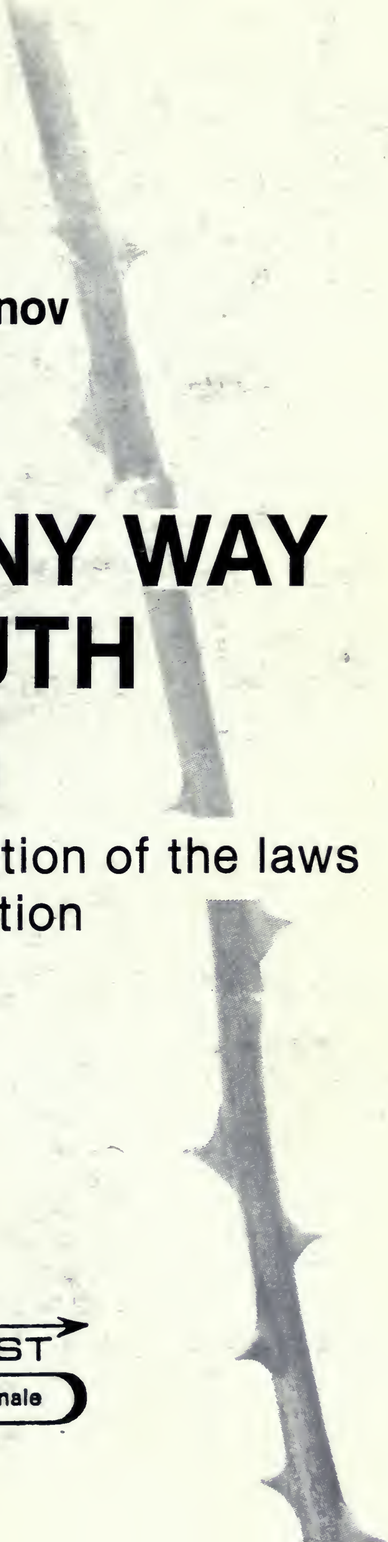
Stefan Marinov

THE THORNY WAY OF TRUTH

Part VII

Documents on the violation of the laws of conservation



EST-OVEST
Editrice Internazionale

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SCIENCE IS A CONGLOMERATE OF LIES ON WHICH THERE IS AGREEMENT.

NAPOLEON

SAVOIR S'ARRÊTER DEVANT L'INCOMPRÉHENSIBLE, C'EST LA SUPRÊME SAGESSE.

Tchouang TSEN

EXPERIMENTIEREN OHNE NACHZUDENKEN IST NUTZLOS, DOCH NACHDENKEN OHNE ZU EXPERIMENTIEREN IST G E F Ä H R L I C H!

CHI INVENTE È SEMPRE SOLO.

A. GIDE (Il immoralista)

NUR WENN DU IMSTANDE BIST, ANTWORTE DEINEM MITMENSCHEN, WENN NICHT, LEG DIE HAND AUF DEN MUND!

JESUS SIRAH (5:12) in dem Brief an die Relativisten von Arimathäa

WO VIELE WORTE SIND, DA HÖRT MAN DEN NARREN.

ECCLESIASTICUS

МЫ НЕ ЧИТАЛИ КАНТА И КОНТА,
НО ТВЕРДО ЗНАЕМ, - ВСЕ ОНИ КОНТРЫ.

B. B.

... ABER DIE SPREU WIRD ER VERBRENNEN MIT UNAUSLÖSCHLICHEM FEUER.

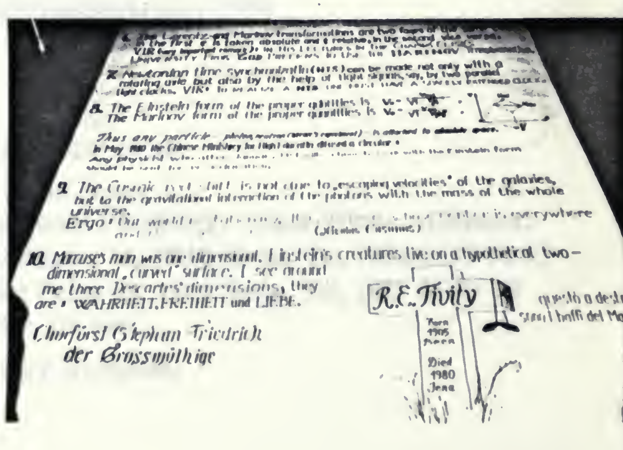
MATTHÄUS (3:12)

- Maestro, Ihre Theorie widerspricht den Experimenten.
- Desto schlimmer für die Experimente.

This cartoon was executed by Filippo Scozzari in Perugia in September 1989 in the record time of $2^m\ 37^s$. For showing that Einstein's theory is a galimatias one needs no longer time.

Einstein's moustaches can be seen hanged up on the grave cross of R. E. Tivity in Marinov's TEN JENA COMMANDMENTS whose complete text is published on. p. viii of vol.I of Marinov's CLASSICAL PHYSICS. The text at the right of the cross runs:

questi a destra
sono i baffi del Maestro.



P R E F A C E

(ПЕРДИСЛОВИЕ)

Giudicateli non dalla differenza di loro linguagio ma dall'identitã dei risultati.

Robespierre in his speech against the supporters of the displacement current concepts.

Quite the whole seventh part of the collection of documents THE THORNY WAY OF TRUTH (TWT) presents my endeavours in showing that Maxwell's displacement current does not exist. I republish enough historical and contemporary papers and excerpts from text-books on this topic, so that the reader can quickly receive a well-documented impression about the view-point of "conventional physics".

There is no unity between the defenders of the displacement current concepts and sometimes the differences are so big that for one and the same experiment different Maxwellians give different predictions. So, for example, G. Mie (p. 124) predicts that a leaky capacitor will not generate magnetic field, while French and Tessman (p. 141) predict that it will generate magnetic field.

However, although different Maxwellians speak different languages, all of them preserve some common rules.

1. There is no Maxwellian after WWI who would mention and discuss Whitehead's experiment (as well as there is no relativist who would mention and discuss Kennard's experiment). Whitehead has carried out a kinetic displacement current experiment which is PURE and, as it shows that there is no motion of a dielectric across which displacement goes when put in an alternating magnetic field, this experiment offers a clear and direct demonstration that the displacement current has no magnetic properties.

2. All Maxwellians discuss only the potential displacement current experiments. These experiments are NOT pure as the alleged magnetic field generated by the displacement current in the condenser is overlapped by the magnetic field generated by the conduction currents in the wires supplying electric charges to the plates of the condenser.

3. The Maxwellians dedicate their whole attention to discuss the displacement current in vacuum and the different theoretical concepts of the different authors differ substantially one from another. However concerning the displacement current in dielectrics (the polarization current) the Maxwellians are quite unanimous: this current generates magnetic field. Meanwhile none (except Whitehead with a negative outcome and Eichenwald with a wrongly interpreted positive outcome) has tried to show whether this assertion is true. With my potential displacement current experiment and with my repetition of Whitehead's kinetic displacement current experiment I showed that the experimental verifications of the absurdity of Maxwell's concepts can be done by children, today, when dielectrics with high permittivity are available.

Now, when I give this book to the printer, I even regret of having compiled such a big book. The question about the displacement current is SO SIMPLE that ten pages are enough to CLOSE THE PROBLEM ONCE AND FOR EVER.

If nevertheless I print this book, it is only to emphasize the IMPORTANCE of the problem, as the dethronization of the displacement current leads to the conclusion that the interactions of current loops are interactions between NON-CLOSED loops if there are condensers in the circuits. From its part this conclusion, in the light of Grassmann's formula for the unequal forces of interaction between current elements, brings us to the conclusion that Newton's third law in magnetism can be violated.

To this problem the scientific community MUST PAY ATTENTION because one of the pillars of contemporary physics becomes shaky.

.....

Now a couple of words on the machine TESTATIKA. On the 27 - 29 October 1989 SAFE (Schweizerische Arbeitsgemeinschaft für Freie Energie) organized a big congress on free energy in Einsiedeln (Switzerland) on which about 700 participants took part. A 30-minutes film on TESTATIKA and on the Christian community METHERNITHA was presented. Representatives of the community gave abundant information on the spiritual and material foundations of the community. I was further working on the organization of the visit of Acad. Sakharov in Linden and on the subsequent presentation of the film on TESTATIKA by the Moscow TV. But in December the heart of the giant ceased beating.

.....

During the congress in Einsiedeln I made contact with some Germano-Americans (whose names at the present time I cannot divulge) who showed to me a helicopter flying with hydrogene peroxyde. After going through special catalysts, H_2O_2 decomposes into H_2O and O_2 under high temperature (about 1300^0) and high pressure. The Germans have used this method in the war to propel torpedoes. In the helicopter, the peroxyde goes through tubes until the extremities of the propeller, where the catalysts are placed. Thus the acting reactive force acts on a lever equal to the half length of the propeller. In this way the flight of the helicopter becomes very stable. The one-man helicopter consumes for one-hour flight 90 liters of peroxyde and the power delivered to the propeller is 90 HP.

I called from Italy my friend Stefano Ricciardi who came with his motor (see TWT-VI, p. 202). The Germano-Americans remained deeply impressed by the efficiency and simplicity of Ricciardi's motor. A preliminary cooperation contract was signed and if both parts will come to mutual understanding, in America in 1990 the production of cars will begin for which the energetic source will be catalytically decomposed peroxyde and the motor will be Ricciardi's machine.

.....

In the future I hope to change no more the contents of my books TWT. Thus in the future I shall reprint the books from the following editions (correcting only the typing errors):

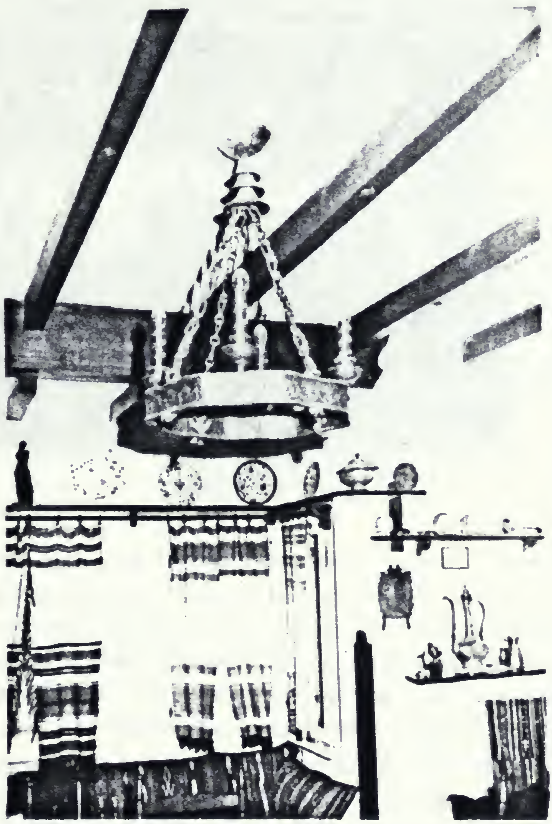
TWT-I - third edition (1988),
TWT-II - third edition (1986),
TWT-III - second edition (1988),
TWT-IV - second edition (1989),
TWT-V - first edition (1989),
TWT-VI - first edition (1989),
TWT-VII - first edition (1990).

All references will be given to these editions and the editions will be no more mentioned.

Graz, 15 March 1990 Stefan MARINOV

Stefan MARINOV

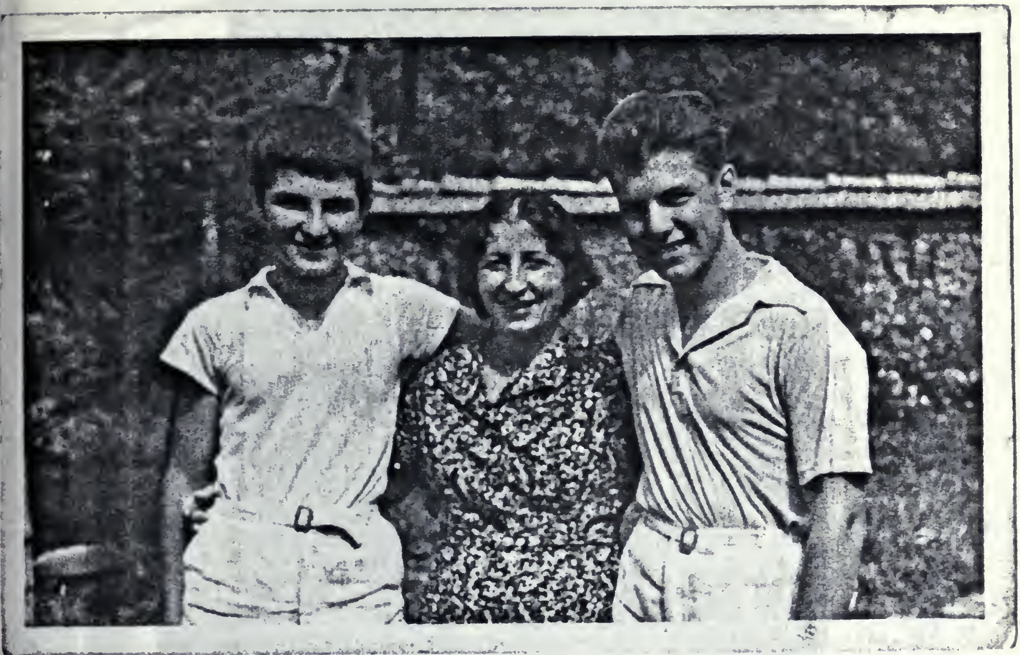
FROM MY PHOTOGRAPHS' ALBUM



This is my native house in the street Elin Pelin Nr. 22 in Sofia. Elin Pelin was one of the classics of the Bulgarian literature who lived in Nr. 12 (he died in 1949). His son Boby was my first boy friend. Elin Pelin was царски човек (king's man) amd when king Boris used to come to visit him, we, the children of the street, were happy of having seen and spoken to the Bulgarian king. I must add that we were not at all amazed that the king was without crown /липсваха и пазвантите, които ходят /пърдон, ходеха/ плътно зад всекиго от "народните" републикански кондукатори/.

Again my native house. Although since eight years I am a poor *Stallknecht* (groom) here in Graz, but I descend from a rich family (увы, уж таковы превратности судьбы!). The father of my mother, Gantcho, was owner of a big plant with 4,000 workers in Constantinople and supplied with bombs and explosives the whole Turkish army. He graduated from the Высшее Пиротехническое училище (High Pyrotechnic School) in Sankt-Petersburg and was a very talented inventor. His sister, Adriana Budevska, was the Bulgarian Eleonora Duse. However, my both parents were communists since their youth. My father joined the Bulgarian Party of Narrow Socialists before the First World War. This was, as a matter of fact, the first (since 1903) communist party in the world, as the Bolsheviks left the social-democracy in 1912 and all revolutionary socialists of Europe did this after WWI. My parents were very good friends of Traitcho Kostov, the secretary of the Bulgarian Communist Party, who was killed in 1949 by the Stalinists around Valko Tchervenkov, blamed of being an Anglo-American agent. Valko Tchervenkov, native from Zlatitza, was a distant cousin of my father.

In 1981 I was deprived of Bulgarian citizenship, accused of being an anti-communist, and my house was confiscated by the government ав дь гоувидър въ Прейвиц.



With my mother, Galina, and my brother, Coliu, in 1944 in the garden of the native house of my father, Marin, in Zlatitza, 76 km far from Sofia, a beautiful picturesque romantic village (WAS!) in the southern skirts of the Balkan. Zlatitza was a Turkish village (касаба). When the liberation Russian army approached in 1877 the Balkans from the north, the Turks sold in a hurry their houses and lands and the grand-father of my father, Gruio, bought quite the whole upper part of the village (and a mill in the lower part). His daugher, Christina, the sister of my grand-mather, Maria, was a communist and member of the central committee of the party between both world wars (she died in 1937). A big part of the relatives of my father were communists, fighting for freedom and social justice in Bulgaria, Germany, Spain, China (the cousin of my father, Ivan Gentchev, was the chief Komintern's agent in Shanghai in the thirties) and the Soviet Union. Two uncles, Christo and Vasil, and one aunt, Nevena, perished in the Stalin's extermination camps в тысяча девятьсот тридцать и проклятых годах.

My mother has studied history of art in Munich during and after WWI. She spoke Russian, German, French, Czech, had a beautiful voice and sang on the piano *Lieder* of Schubert, Schumann, Russian romances and Soviet airs. She was a passionate Wagnerian and her greatest dilight was to hear classical music. I do not remember my mother ailing and she never in her life has visited a dentist.


— 2 —

Das Lichtbild ist spätestens nach 5 Jahren zu erneuern; vorher ist es zu erneuern, wenn es unkenntlich oder unähnlich geworden ist. Das neue Bild ist auf S. 3 und nach Bedarf später auf S. 4 zu setzen.

Unterschrift des Inhabers:

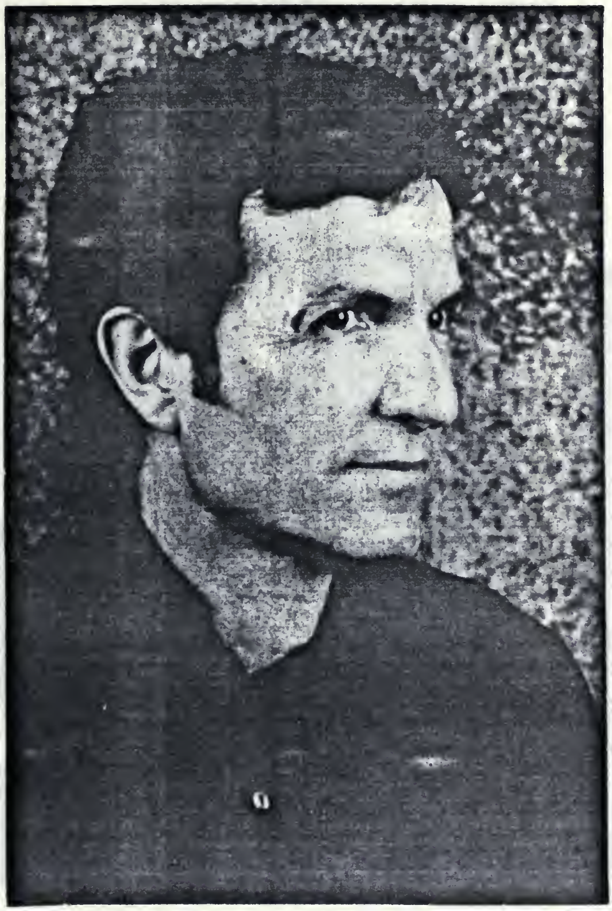
S. Marinov

Es wird bescheinigt, daß der Inhaber die durch das obenstehende Lichtbild dargestellte Person ist und die darunter befindliche Unterschrift eigenhändig vollzogen hat.

Hamburg-Altona, den 10. MRZ. 1958 19....

Das Seemannsamt

I began to study physics in Prague's Charles University in 1948 (my father was a diplomate in Prague). In 1951, in the apogee of the cold war, following the appeal of the Bulgarian government and communist party, I interrupted my studies in physics and went as a volunteer to the Varna High Navy School. After graduating, I sailed as deck officer on Bulgarian, Czechoslovak-Chinese and West-German cargoes on the world's oceans and seas. The picture above is taken on the German ship "Bernhard Howaldt" in the Indian Ocean in 1958. The captain, Malte Wittstock, has served from the first to the last day of the war on nazi submarines. I do not remember of having met a more calm and well-poised person. Once in a narrowness in the Red Sea, I took a wrong decision which could lead to collision with another ship. Captain Wittstock, who rarely mounted the bridge, by an unexplainable "command of the fate", appeared at the most critical moment, corrected my error and by no muscle of his face showed to me that I have brought the ship to the threshold of a disaster.



On the 29 April 1978 at 11.00 I carried out a demonstration on the Venceslao square in Prague in support of Charter 77. Support to Charter 77 was given by dissident groups in all East-European countries. Only from Bulgaria (as always) no voice was heard. I decided to go from Brussels to Prague and to manifest my solidarity under the head of the horse of Saint Venceslao. I announced the demonstration to Jiri Hajek, Julius Tomin, the son of Ludvig Vaculik and the only representative of the Western Press, Mr. Lamourieux (I hope, I spell well his name) from Agence France Press. The demonstration was betrayed (I think Mr. Lamourieux did this), as when I cameto the upper part of the square, there were around dozens of policemen. When I approached the monument a policeman asked for my documents. Until he looked at the identity card, I rushed to the monument, exactly under the head of the horse where two other policemen stayed and rolled out my poster with the following text: "Vaše charta - naše charta, Marinov - Bulharsko" (Your charter is our charter, Marinov - Bulgaria). My intention was to write the following text: "Vaše charta - naše charta, my jsme všichni jedna parta", but J. Tomin said that such a text is of the kind of the slogans "Kdo dnes sedí na chodníku, nemiluje republiku" and added "V čestině slovo 'parta' se užyvá spíš jako parta do hospody". And he gave me the advice to cancel the last words what now I regret of having done. Tomin said to me that my demonstration on the Venceslao square will be the first one after 1969. I am proud that the demonstrations for freedom in Prague, in which now hundreds of thousands take part, began with my one-man demonstration. A končím slovy které se Tominovi určitě líbit nebudou:

Vykrájem si pěkný kus svobody
a půjdem potom do hospody.

This picture is taken in Washington, D.C., where I spent some of the happiest months in my life. --- On the 3 April 1974 I could escape from the psychiatry in Sofia where for a second time I was detained because of my political dissent. After changing my pyjamas with the cloths of a friend of me, I entered the American Embassy to present an address to the world protesting against my imprisonment in a psychiatric clinic. The employees, who knew me very well, instead to help me, called secretely the Bulgarian police. Two well-trai ned muchachos of the special services (SS) beated me vandalically in the hall of the Embas and brought me back to the psychiatry. In 1976 when J. Carter won the elections and raised the banner of human rights, I presented in the Embassy a claim for injury but I received only a bureaucratic answer (see the relevant correspondence in my book Изыди, Сатана!). When in 1977 I arrived in Belgium, I addressed President Carter directly, asking for his excuses for the barbaric beating. In June 1978 I was invited by the American Embassy in Brussels to visit Washington for better investigation of the case and of my scientific background. Half a year I was in an active contact with the State Department, the White House, the NBS, the NSF, NASA and several democratic and republican members of the Congres But in December 1978 the Immigration Office expelled me. When I went to Mr. Ivan Sipkov, a Bulgarian who was introduced to me by the State Department, shouting loudly: "How is this possible!? Which is this idiotic bureaucracy in this stupid country! I am awaiti for the answer and for the excuses of the President of USA and these bloody guys expell me Mr. Sipkov smiled: "Be calm and go to pack your luggage. This is the answer of Carter... and of your friends relativists."

At the International Conference on Space-Time Absoluteness (ICSTA) in July 1982 in Genoa, with Prof. J. P. Wesley and Prof. J. P. Provost. This was the second ICSTA-conference. The first one had to meet in Bulgaria in May 1977 but it was prohibited by the Bulgarian government and 20 days before the opening I was imprisoned (for a third time) in a psychiatric clinic. On the day on which I shall find money, I shall announce the third ICSTA-conference to seal on it the death of relativity.

December 1982 (or February 1985). My meager dinner as poor groom in Niederschöckl.
(Photograph by P. T. Pappas).

PS. The number of the sweaters on me speaks about the cold in my room.

Marinov

NATURE VOL. 311 4 OCTOBER 1984 399

Further threat of immolation

BRITISH diplomatic missions in Genoa (Italy) and Vienna (Austria) have been under siege in the past few weeks by Dr Stefan Marinov, the Bulgarian physicist now living in the West, with threats of self-immolation. Dr Marinov is protesting at the refusal of the Editor of *Nature* to publish three long scientific articles, one of which is a restatement of Marinov's theory of absolute space-time, another of which announces the design of a *perpetuum mobile*.

Dr Marinov first embarked on self-immolation in Genoa on 8 August, outside the British Consulate, but by his own account was held in conversation for half an hour by staff from the consulate and was compelled to flee when the staff sought the assistance of the police, knowing that he was present illegally in Italy (having been denied entry in 1980).

At a press conference held in Austria last week, Dr Marinov again announced his plan for self-immolation, this time outside the British Embassy in Vienna. On the telephone earlier this week, he said that he would take this step at 10 a.m. local time on 2 October but, on being informed of the appearance of this piece, said "Now I don't know whether to immolate myself tomorrow".

Dr Marinov's claims that Einstein's theory of special relativity is misplaced were first made in 1974 (*Czechoslovak J. Phys.* B24, 965; 1974), on the basis of an experiment carried out in Bulgaria that purported to show that the velocity of light is direction-dependent. Marinov has since claimed to have repeated the experiment. The paper describing that investigation, "New measurement of the Earth's absolute velocity with the help of the coupled shutters experiment", says that the experiment was carried out in his girl-friend's apartment, that the rotating shutters, functioning as a siren, disturbed the neighbours and that "after a couple of altercations, my girl-friend threw away from her apartment not only my apparatus but also me".

The two other papers submitted for publication are called "On the action and interaction of stationary currents" and "*Coup de grace* to special relativity and to something else". All three papers have now been published by Marinov in his book *The Thorny Way to Truth* (Part II).

Marinov's complaint against *Nature* is primarily that publication of these three papers has been refused, but also that "milliards of dollars" are being lost each day the world remains ignorant of his perpectual motion machine. Other matters in dispute are *Nature*'s refusal to publish an appeal to the late Yuri Andropov at the end of last year and, earlier, a manifesto called the "Ten Jena Commandments".

John Maddox

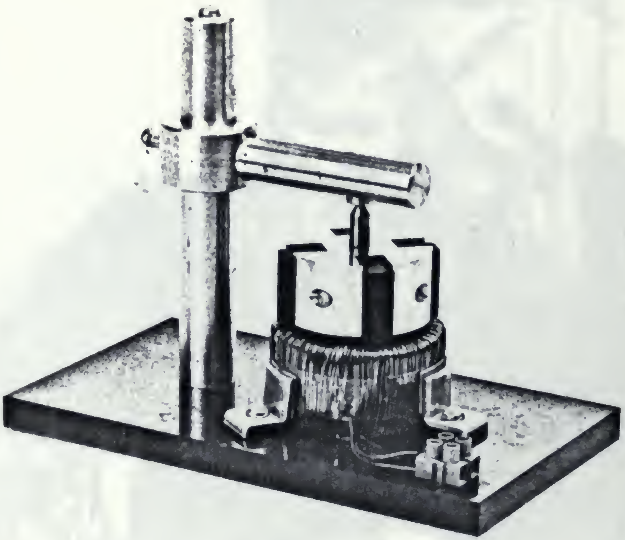
September 1983. On the streets of Graz, alone, with my "coupled mirrors" experiment, absorbed in thoughts about the thorns on which has one to tread for reaching the shining summits of scientific truth.

February 1984. Explaining the essence of the "coupled mirrors" experiment. My fingers show the ways in which both light beams go from the one perforated disk to the other. One can see on the photograph only a small part of the laser producing the initial light beam which is split by the semitransparent mirror seen in the photograph. The reflected beam goes to the left, while the refracted beam, after a reflection on the mirror seen in the photograph, goes to the right. Between the perforated disks, these two beams proceed in the opposite directions.

The person who gave me a possibility to carry out my "coupled mirrors" experiment in his laboratory took from me the solemn promise that I shall never say where have I carried it out. To my question, why is he so afraid, the answer was: "I do not wish one day to be poisoned by certain special services (SS)."

April 1984. With the first model of the effective Bul-Cub machine. In the photograph above the Bul-Cub machine is working as a generator, as the rotor is rotated by an electromotor on the right and from the wires on the left one obtains a direct tension. The Bul-Cub machine is the first one-and-a-half polar machine in the world (according to my classification of the electromagnetic machines). Francisco Müller (Miami, USA) was the first man who has constructed one-and-a-half polar generators. I constructed the first one-and-a-half polar motor and called these machines, in honour of Müller's and my native countries (Cuba, Bulgaria) the BUL-CUB MACHINE.

The Bul-Cub machine without stator which I constructed in 1987 was the first machine in the world which demonstrated violation of Newton's third law and of the law of angular momentum conservation. The world's scientific bulls refuse to analyse the Bul-Cub machines, because the motional-transformer induction comes there patently to light.



May 1984. One of my machines with negative outcome to which, now, I give the name BUL-MACHINE. --- If one will wind on the plastic torus only a couple of windings near one to another, leaving the other part of the torus without windings, there will be a torque acting on the lower pole of the vertically fixed magnet and the magnet will be pushed from the one side of the windings to other side. The explanation is the following: The magnetic intensity field over the windings is horizontal and it pushes the near positive magnetic pole in the direction of the field. Thus one should expect that if the whole torus will be covered by windings, as the field will be the sum of the fields of any of the windings, the magnetic force lines will go over the torus horizontally and will bring to rotation the four vertically fixed magnets. This, however, is not true. There is no torque acting on the rotor above. Indeed, for a toroidal coil, the whole magnetic field is in the torus, and the field outside the torus is null. This experiment gives a confirmation of the assertion that a direct current motor without sliding contacts cannot be constructed. This experiment also shows that any d.c. motor without sliding contacts will inevitably be a perpetuum mobile. If one would have a magnetic monopole, then the field in the torus will set this monopole into a continuous rotation. Thus all those who since many years are searching for magnetic monopoles are, simply, idiots.

The Bul-Cub machine represents a certain development of the Bul-machine. The effective Bul-Cub motor rotates. It has no sliding contacts but there one makes short-circuiting of the windings "outside" the poles. I have not made the Bul-machine effective by short-circuiting the windings "outside" the poles, but this, surely, can be done.

After the expulsion in December 1978, I submitted several applications for visa at the American embassies and consulates in Brussels, Genoa and Vienna but always my application was rejected by the motivation that I am communist (see TWT-I, pp. 150 and 184). Even the intervention of my friend, the member of Congress Robert Dornan (he tapped me on the shoulder calling me "Steve" and I tapped him on the shoulder calling him "Bob") remained without success (see TWT-I, pp. 124 and 149). But the categoric intervention later of my friend, Dr. Henry Dart, an acanite anti-relativist from Tucson, impelled the Washington administration to issue me a visa. Dr. Dart sent telegrams to the American Ambassador in Vienna and to President Reagan, saying that he is an American, a free citizen in a free country, and he wishes to have me as a guest in his house in Tucson. The administration has not the right do decide for him, whom he has to receive and whom he has not. Dr. Dart even cited a poem of Maiakovsky:

И да будет тебе понятно, бумажно-крысина мафия,
в последний и пост-последний раз, -
не мы ради чиновничьей кристаллографии,
а вы, чиновники-гады, для нас!

In a beautiful sunny day in November 1985 (in Arizona 300 days of the year are beautiful and sunny) I visited with Dr. Dart the Kitt Peak Observatory and he took the picture above.

February 1986. In the house of my brother in North Sydney.

In August 1986, together with Prof. P. Pappas who came to take me from Graz, I visited the International Symposium on Electromagnetic Theory in Budapest, where I was accepted as a participant. However, the president of the local organizing committee, a very nice and intelligent Hungarian, whose name I unfortunately have forgotten (something like Szekeresz-Mekeresz) said that it will be not allowed to me to present a poster. He looked at me with such kind and understanding eyes that I did not wish to torment him and to ask "WHY". I showed only to him the poster tables: 80% of the tables were FREE. "Yes, yes, he said, I know that there are free tables, but..." And he could say nothing after this "but". Then I went to the president of the international scientific committee, Prof. Bachmann*(I hope, I spell well his name) and begged him to send to my address in Graz a written explanation for the motivations why, once accepted as a participant at the congress, the scientific committee does not allow me to present a poster. Dr. Bachmann promised to send me such a written explanation. Until the present day I am expecting his letter.

In the photograph above one can see the building where the conference took place. A very nice building, *nicht wahr?* - *I g e n , i g e n .*

---

* or Bach, or something like that.

In October-November 1987 I visited Moscow with the intention to convince Acad. Sakharov that the laws of conservation can be violated. My efforts remain vain (see TWT-III, p. 239). The conclusion of Sakharov was: "Меня, конечно, можно переубедить, но тру-у-дно." (One, of course, might REconvince me, but dificultly.) Sakharov was again (as during my visit in February 1978) very pessimistic about the future of Russia. I wished to grant him my satirical book Изыди, Сатана!. "А зачем мне Ваша книга?" (Why for is your book for me?) "А шоб посмеяться, Андрей Дмитрич." (To laugh a little bit, Andrei Dmitritch.) "Чего мне смеяться, когда мне пла-кать хочется." (Why have I to laugh when I wish only to weep.) He said the last words with such a deep sorrow that one had only to seat near him and to begin to cry.

This is not a photomontage. This picture shows that the Special Services (SS) of Special Relativity (SR), which put on my brest the yellow David star, are always behind my back following severely every my pace.

Drinking *Brüderschaft* with SR (Satanic Relativity).

I publish this picture, so that my cousins can see that I have also a Budevsky-nose. My mother was of the Budevsky family of which there are only few descendants in Sofia and Dobritch (Dobrudja). All Budevskies have a very characteristic nose (see my mother's nose on p. 9).

SCIENTIFIC PAPERS

REPETITION OF WHITEHEAD'S EXPERIMENT FOR DEMONSTRATING THAT DISPLACEMENT CURRENT IS A PURE MATHEMATICAL FICTION

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Abstract. According to conventional physics, Maxwell's displacement current has the same magnetic properties as conduction currents, i.e., it acts with potential forces on other currents and reacts with kinetic forces to the action of other currents. In another paper(1) I showed by a simple and reliable original experiment that displacement current has not the first of these properties. In this paper I give the report on my repetition of the historical simple and reliable Whitehead's experiment(2) which shows that displacement current has neither the second of these properties.

1. INTRODUCTION

According to the conventional electromagnetic theory, which has canonized Maxwell's "closed currents" and "flux" concepts, in the vacuum between the plates of a condenser charged to the tension U(t), the so-called displacement current flows whose density is

$$\mathbf{J}_{dis} = -\varepsilon_0 \partial\{\mathrm{grad}U(t)\}/\partial t = \varepsilon_0 \partial\mathbf{E}(t)/\partial t, \quad (1)$$

where $\mathbf{E}$ is the Coulomb electric intensity generated by the charges on the condenser's plates at the considered reference point and ε_0 is the electric constant.

In the case that there is a dielectric with permittivity ε between the plates of the condenser, the density of the displacement current will be

$$\mathbf{J}_{dis\varepsilon} = \varepsilon\varepsilon_0 \partial\mathbf{E}/\partial t = \partial\mathbf{D}/\partial t, \quad (2)$$

where $\mathbf{D}=\varepsilon_0\varepsilon\mathbf{E}$ is called electric displacement. Conventional physics calls

$$\mathbf{J}_{pol} = \mathbf{J}_{dis\varepsilon} - \mathbf{J}_{dis} = \varepsilon_0(\varepsilon-1)\partial\mathbf{E}/\partial t \quad (3)$$

polarization current, retaining for (1) the term displacement current in vacuum and for (2) the term displacement current in dielectric.

As I shall show in this paper, the displacement current is a pure mathematical fiction without any physical background, i.e., displacement current neither acts on other currents with potential forces (i.e., it does not generate magnetic potential) nor reacts with kinetic forces to the action of other currents (i.e., it is insensitive to external magnetic potentials). Thus the notion "displacement current" is superfluous but I retain it in my theory, as otherwise I cannot communicate with the rest of the scientific community, emphasizing, however, once more that this notion is a mathematical fiction. I evade to use in my theory the notion polarization current which is totally superfluous, and as there is no substantial difference between displacement current in vacuum and displacement current in dielectric, I shall usually write $\mathbf{J}_{dis\varepsilon}$ omitting the index ε.

If the charged plates of a condenser will be set in motion, the so-called convection current (more precisely convection current of free charges) will flow. This current has the same magnetic properties as conduction current flowing in a piece of metal when there is an electrical tension between its extremities, i.e., it generates magnetic fields and reacts with ponderomotive forces to the action of external magnetic fields. (Note that in my theory(3) under "magnetic field" one has to understand rather the field of the magnetic potential and not the field of the magnetic intensity; the difference is subtle but important.) First Rowland(4) has verified this experimentally.

If the polarized dielectric put between the plates of a charged condenser will be set in motion, the so-called convection current of bounded charges will flow. This current too has the same magnetic properties as conduction currents, i.e., it generates magnetic potential and reacts with kinetic forces to external magnetic potentials. First Röntgen(5) has verified this experimentally and certain authors call it Röntgen current. Following this trend, one has to call the convection current of free charges Rowland current.

In the present paper I shall analyse only the displacement current leaving the Rowland and Röntgen currents without attention.

In Ref. 1 I gave the report on an original experiment which demonstrated that displacement current does not generate magnetic field, called the potential displacement current experiment.

In this paper I shall give the report on my experiment representing, as a matter of fact, a repetition of the historic experiment of Whitehead(2) which demonstrated that displacement current does not react with kinetic forces to the action of other magnetic fields, and which I call the kinetic displacement current experiment.

But first (in section 2) I shall give a short survey of all potential displacement current experiments carried out on this Earth and of my own(1) potential experiment.

2. MARINOV'S POTENTIAL DISPLACEMENT CURRENT EXPERIMENT

One cannot make a closed loop only with displacement current, as always wires with conduction current must be present in the loop. Thus one cannot observe the potential magnetic action of a displacement current element, as the detector will always register also the potential magnetic action of the conduction current elements present in the loop. It is to be noted, however, that the kinetic magnetic action on a displacement current element can be observed, so that the kinetic displacement current experiments must be considered as more reliable than the potential displacement current experiments.

Eichenwald[6] was the first (after the inconclusive experiments of Röntgen[7]) who has reported of having measured potential magnetic action caused by displacement current. As a matter of fact, the effects which Eichenwald has observed (deflection of a magnetic needle) were caused by the magnetic action of the conduction currents in the wires transferring charges to the plates of the condenser and NOT to the magnetic action of the displacement current in the dielectric between those plates, as Eichenwald, following Maxwell, supposes. When a dielectric disk rotates between two charged electrodes there is always a transfer of electrons from the negative to the positive electrode. Exactly this is the case in Eichenwald's experiment, in which two pairs of oppositely charged electrodes are placed on both sides of the rotating disk of dielectric. If Eichenwald had put an amperemeter in his electrical circuit, he would have seen that when the disk begins to rotate also current begins to flow in the circuit. Everybody who has constructed electrostatic motors has observed this effect (see TWT-V, pp. 22 - 26).

Besides the experiment of Eichenwald, where the displacement current was in dielectric, there is only the experiment of Bartlett and Corle[8] where the authors claim of having observed the potential magnetic action of displacement current flowing in vacuum between the plates of a condenser (the indicator of the magnetic field was a superconducting quantum interference detector). By the help of childishly simple calculations I showed[1] that the effect measured by Bartlett and Corle has been due to the magnetic action of the conduction current flowing in the wires transferring electric charges to the plates of the condenser, and NOT to the magnetic action of the displacement current, as Bartlett and Corle, following Maxwell, suppose.

Now I shall briefly describe my potential displacement current experiment (fig. 1) with whose help I established[1] that displacement current (my displacement current was in dielectric) does NOT generate magnetic field.

An alternating current, always of the <u>same</u> intensity I (=10 mA in my experiment), coming from infinity and going to infinity crosses a condenser with parallel circular plates in the form of displacement current in dielectric (barium titanate with $\varepsilon = 10^4$ in my experiment). The most simple theory leads to the result that if d is the distance between the plates and r is the distance from the center of the condenser to a reference point along a line perpendicular to the axis of the condenser, then, at $R \ll r$, where R (= 4 cm in my experiment) is the radius of the circular plates, the magnetic intensity at the reference point will be

$$B_d = \frac{\mu_0 I}{2\pi r}\{1 - \frac{d}{(d^2 + 4r^2)^{1/2}}\} \cong \frac{\mu_0 r I}{\pi d^2} \tag{4}$$

for the case when we take into account only the magnetic intensity generated by the conduction currents and assuming that the displacement current does not generate magnetic field (the approximation in (4) is taken for $d \ll r$).

If, however, we shall proceed from the Maxwell concepts (but NOT from the Maxwell equations!), the magnetic intensity must be

$$B_0 = \mu_0 I/2\pi r \tag{5}$$

for any value of d. According to my concepts such will be the magnetic intensity only for d = 0.

The experiment was done for d varying from zero to six cm with changes of 1 cm. I measured the magnetic intensity produced only by the "positive" pulses of the current by the help of a Hall sond put at a constant distance r (= 10 cm) from the central point of the condenser's axis. The magnetic intensity in my experiment was of the order of hundred micro-Gauss and the output of the Hall sond after amplification was led to a galvanometer. As my measurements were only relative, the galvanometer of the Hall sond was neither calibrated.

The measured ratios B_d/B_o were pretty near to the calculated according to formula (4) ratios. For d = 1 cm the decrease of B was with 40% less for the measured value than for the calculated one but with the increase of d this inaccuracy diminished becoming 0% for d = 6 cm. This was a good indication that formula (4) is valid only for $R \ll d$.

3. THE HISTORIC WHITEHEAD'S KINETIC DISPLACEMENT CURRENT EXPERIMENT

Whitehead presents the essence of his experiment with the following words:

> Das Prinzip der Methode ist, ein Stück eines Dielektrikums einem elektrischen Wechselfelde und einem magnetischen Wechselfelde auszusetzen, die Phasen der beiden Wechselfelder, deren Richtungen in Raume rechtwincklig aufeinander stehen, so zu justieren, daß die Reaktion des Verschiebungsstromes gegen das Magnetfeld ein Maximum wird und zu beobachten, ob eine Bewegung des Dielektrikums in einer Richtung, die senkrecht zu der Ebene erfolgt, welche das wirksame elektrische und magnetische Feld umfaßt, eintritt.

Thus Whitehead intended to see whether a piece of dielectric, across which displacement current with a certain frequency went through, should begin to move if acting on it with an alternating magnetic field perpendicular to the displacement current and having the same frequency.

The Maxwellians assert that the dielectric must begin to move as the force acting on the displacement current in the dielectric will always have the same direction. However Whitehead's experiment showed that there is NO motion.

Whitehead has constructed two types of apparatus.

The first type of Whietehead's apparatus is shown in fig. 2, where the upper drawing shows the cross-section of the apparatus in the vertical plane and the lower drawing shows the cross-section in the horizontal plane.

AA were two rectangular blocks of dielectric (Whitehead used rock-salt, glass and paraffin but the data given in the article refer only to rock-salt) suspended on a sensitive quartz torsion fibre. BBBB were two pairs of brass electrodes whose surfaces had the curvature of two cylinders coaxial with the torsion fibre. The two brass condensers were charged by an alternating tension. CC were two cylindrical coils, each of which encircled one of the condensers. The turns of the coils were horizontal and they were feeded by the same tension as the condensers. At the bottom of the apparatus there was a mica lamella suspended in water (not noted by some letter in the drawing) which served to damp the oscillations.

The torque acting on the two pieces of dielectric, according to Maxwell's concept, had to be (I write the formulas which follow again in the SI system of units)

$$\mathbf{M} = |\int \mathbf{r}\times\mathbf{F}\, dV| = r F V, \tag{6}$$

where V was the volume of <u>both</u> blocks of dielectric (= 1.26 cm^3, as calculated from the sizes of the blocks), r (= 17.8 cm) was their distance from the axis of suspension,

$$\mathbf{F} = \mathbf{J}_{dis}\times\mathbf{B} \tag{7}$$

was the density of the magnetic potential force acting on the displacement current, with magnetic intensity **B** and density of the displacement current

$$J_{dis} = \varepsilon_0\varepsilon\partial E/\partial t = (\varepsilon_0\varepsilon/d)\partial U/\partial t, \tag{8}$$

where ε (= 5.8) was the permittivity of the used rock-salt,

$$U = U_0\cos(2\pi\nu t) \tag{9}$$

was the alternating tension applied to the condensers with amplitude U_0 ($=\sqrt{2}\,8.8$ kV) and frequency ν (= 133 Hz), and d (= 1.9 cm) was the distance between the condensers' electrodes, ε_0 (= $10^{-9}/36\pi$ F m^{-1}) being the electric constant.

Thus the amplitude of the displacement current density was

$$(J_{dis})_0 = (2\pi\varepsilon_0\varepsilon\nu/d)U_0. \tag{10}$$

The amplitude B_0 of the alternating magnetic intensity is not given explicitly in Whitehead's paper. I have calculated B_0 from the formula of an infinitely long cylindrical coil with n turns on a unit of length, taking n = N/h, where N (= 1200) was the number of the turns in Whitehead's coils and h (= 6 cm, as I evaluated from the drawing, taking into account that the height of the dielectric block was 1 cm) was the height of the coil, so that

$$B_o = nI_o = (N/h)I_o, \qquad (11)$$

where I_o (= $\sqrt{2}$1.2 A) was the amplitude of the flowing current.

Putting the figures in formulas (10) and (11), we obtain

$$(J_{dis})_o = 0.028 \text{ A m}^{-2}, \qquad B_o = 3.4\times10^4 \text{ A m}^{-1} = 0.043 \text{ T}, \qquad (12)$$

and for the acting force on both blocks we find, if we note by $T = 1/\nu$ the period,

$$F = \frac{1}{T}\int_0^T (J_{dis})_o \cos(\frac{2\pi}{T}t)\, B_o \cos(\frac{2\pi}{T}t)\, dt = (J_{dis})_o B_o/2 = 3.3\times10^{-4} \text{ N m}^{-3}. \qquad (13)$$

Thus from formula (6) we find the acting torque (moment of force)

$$M = 7.4\times10^{-11} \text{ N m} = 7.4\times10^{-4} \text{ dyne cm}. \qquad (14)$$

Whitehead's calculation of the torque M are cumbersome and unclear. He obtained the following value for the acting torque: $M_{Whitehead} = 10^{-4}$ dyne cm.

Whitehead gives the angle of rotation of the mirror fixed to the lower end of his quartz fibre of length l (= 101.6 cm) and of radius r (= 6 μm), at an acting torque M, as

$$\theta = 2lM/\pi n r^4, \qquad (15)$$

where, for quartz, the coefficient n is 3×10^{11} dyne cm^{-2}. Thus the expected angle of rotation will be, if we take for M Whitehead's value M_W, $\theta = 0.17$ rad.

As Whitehead notes, such an angle of rotation corresponded to a displacement of the light spot reflected by the mirror over 485 mm. Meanwhile no displacement greater than 2 mm has been observed during hundreds of measurements.

The second type of Whitehead's apparatus (fig. 3) was much cleverly constructed. It consisted of a single big cylindrical coil with height 7.63 cm, internal diameter 26.6 cm, and 360 turns. There was only one condenser whose cylindrical electrodes were coaxial with the coil and the suspension fibre. Now the two dielectric blocks could rotate over 360^o in the space between the condenser's electrodes.

Whitehead does not give numerical data for the measurements with the second type of his apparatus. He only notes that also here no torque, contrary to Maxwell, has been observed.

4. MARINOV'S REPETITION OF WHITEHEAD'S KINETIC DISPLACEMENT CURRENT EXPERIMENT

My experimental set-up (figs.4,5) was, in principle, a duplication of the second Whitehead's apparatus (see the end of the previous section). The differences were the following:

1. My dielectric was not in the form of two tiny blocks but in the form of a cylindrical ring, thus assuring a complete geometrical and physical symmetry.

2. The cylindrical ring of the dielectric could be set in continuous rotation as it was suspended on ball-bearings.

3. I took a big and long enough cylindrical coil, so that the magnetic field in its central part, where the condenser was put, had a perfect cylindrical symmetry.

4. I took as dielectric the substance Y5U 153UL of the electric company SIEMENS (lead-iron-tungstanate) with very high permittivity ($\varepsilon \cong 1.5\times10^4$ when sintered and about 10^4 when only pressed as in my experiment), so that the capacitance of the condenser was practically determined only by the capacitance of the two ring vacuum gaps which enabled the rotation, and as they were pretty small, I could send through the condenser a considerable displacement current.

5. The most important difference between my experiment and that of Whitehead was, however, the following: I did the experiment <u>once with a dielectric ring</u> and <u>once with a metal ring</u>. In the latter case conduction current went through and brought the ring in rotation, however in the former case displacement current went through and there was NO motion. In both cases I made the capacitances equal and in both cases I sent exactly the same current through the circuit. The condenser was connected in series with the coil supplying the magnetic field and I made the condenser with such geometry that its capacitive reactance balanced exactly the inductive reactance of the coil for the used frequency of the electric tension and there was no phase difference between the applied tension, U = 300 V, and the flowing current, I.

My experiment thus showed clearly that conduction currents react with kinetic forces to the acting magnetic field but displacement currents DO NOT.

The sizes of my coil were: height H = 260 mm (as there were two plastic covers with thickness 5 mm each up and down, the height of the copper was H' = 250 mm), external radius R_e = 130 mm, internal radius R_i = 64 mm (as there was an internal plastic cylinder, the internal radius of the copper was 69 mm).

The coil had N = 140,000 windings of a copper wire with diameter 0.3 mm and ohmic resistance R = 20,000 Ω. The flowing current at resonance was thus I = U/R = 15 mA and the magnetic intensity generated by the coil in its internal part was, according to formula (11), $B = (N/H')I = 8.4\times10^3\ \mathrm{A\,m^{-1}} = 0.011$ T.

The sizes of the capacitor were: height h = 80 mm, internal radius (i.e., external radius of the internal cylindrical electrode) r_i = 24 mm, external radius (i.e., internal radius of the external cylindrical electrode) r_e = 56 mm.

I made two "rotors" which were put in the condenser's gap and could rotate on two ball-bearings, as shown in fig. 4.

The <u>first</u> "rotor" was of <u>dielectric</u>. The powder substance Y5U 153UL was pressed in a cylindrical box with metal cylindrical walls and plastic lids. The metal walls were pretty thin with a thickness Δ = 1.5 mm. The distances between these walls and the condenser's electrodes were δ = 0.4 mm.

By applying a tension with variable frequency, I established that a resonance took place very nearly to the frequency ν = 200 Hz. As my coil had an inductance L = 3700 H, the capacitance of the condenser was $C = 1/4\pi^2\nu^2L$ = 0.17 nF.

I calculated C in the following way: I considered the condenser as three cylindrical condensers, having the same height h = 80 mm, connected in series. The first was a vacuum condenser with external and internal radii $r'_e = r_e$ = 56 mm, $r'_i = r_e - \delta$ = 55.6 mm. The second was a condenser filled with dielectric with permittivity ε = 10,000 and I assumed, for simplicity, that the thin metal walls have the same permittivity. Thus its external and internal radii were $r''_e = r'_i$ = 55.6 mm, $r''_i = r_i + \delta$ = 24.4 mm. The third condenser was again a vacuum condenser with external and internal radii $r'''_e = r''_i$ = 24.4 mm, $r'''_i = r_i$ = 24 mm. The resultant capacitance was, by the formula for cylindrical condensers

$$1/C = 1/C' + 1/C'' + 1/C''' = (1/2\pi\varepsilon_0 h)\{\ln(r'_e/r'_i) + (1/\varepsilon)\ln(r''_e/r''_i) + \ln(r'''_e/r'''_i)\}, \quad (16)$$

and, obviously, the capacitance C", as very big with respect to the capacitances C' and C"', can be neglected, so that the calculation gave C = 0.19 nF.

The <u>second</u> "rotor" was of <u>metal</u> and had exactly the same sizes as the first one. Formula (16), where capacitance C" is to be put equal to infinity, obviously will yield the same result for the common capacitance C.

When the metal "rotor" was suspended in the condenser's gap, I observed a slow rotation of about half a revolution per second. When the dielectric "rotor" was suspended, NO rotation was observed. Only at certain positions of the dielectric "rotor" sometimes there was a small displacement of about 4 - 5 degrees when closing the circuit. I explained these very feeble impulses by the torque acting on the conduction current in the thin metal walls.

Let us see which was the torque acting on the metal "rotor". This torque will be given by formula (6) which we shall write now in the form

$$M = \int_{r''_i}^{r''_e} r(I\,dr)\,B = (1/2)\,I\,B(r''^2_e - r''^2_i). \tag{17}$$

Putting here I = 15 mA, B = 0.011 T, r''_e = 55.6 mm, r''_i = 24.4 mm, we obtain $M = 2.06\times10^{-7}$ N m = 2 dyne cm.

Consequently, remembering that Δ = 1.5 mm was the thickness of the metal walls of the dielectric box, we shall have for the torque acting on the <u>external</u> metal wall

$$M' = (1/2)I\,B\{r''^2_e - (r''_e - \Delta)^2\} \cong I\,B\,r''_e\,\Delta. \tag{18}$$

Putting here the relevant figures, we find $M' = 0.14\times10^{-7}$ N m = 0.14 dyne cm.

REFERENCES

1. S. Marinov, The Thorny Way of Truth, Part I, p. 317 (East-West, Graz, 1988).
2. J. B. Whitehead, Physik. Zeitschr., **4**, 229 (1903).
3. S. Marinov, The Thorny Way of Truth, Part I, p. 310 (East-West, Graz, 1988).
4. H. A. Rowland, Sitzungsber. d. k. Akad. der Wissensch. zu Berlin, p. 211 (1876).
5. W. C. Röntgen, Wied. Ann., **35**, 264 (1888); **40**, 93 (1890).
6. A. Eichenwald, Ann. der Physik, **11**, 421 (1903).
7. W. C. Röntgen, Sitzungsber. d. k. Akad. der Wissensch. zu Berlin, p. 195 (1885).
8. D. F. Bartlett and T. R. Corle, Phys. Rev. Lett., **55**, 59 (1985).

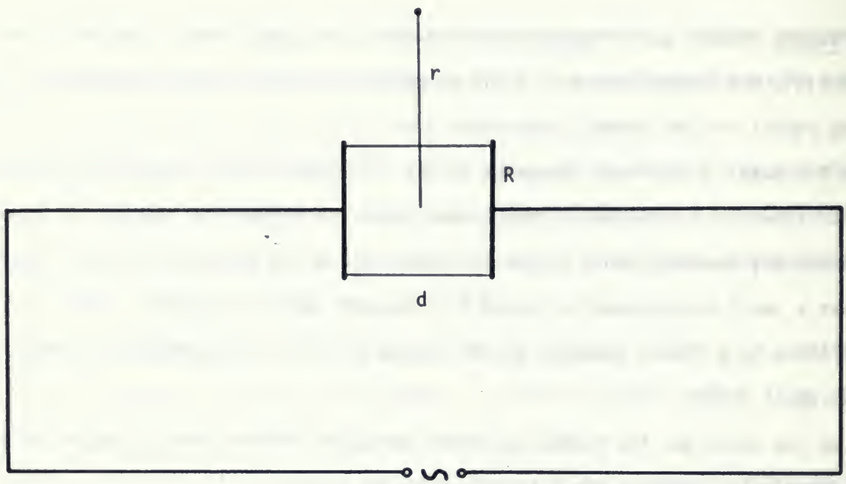

Fig. 1

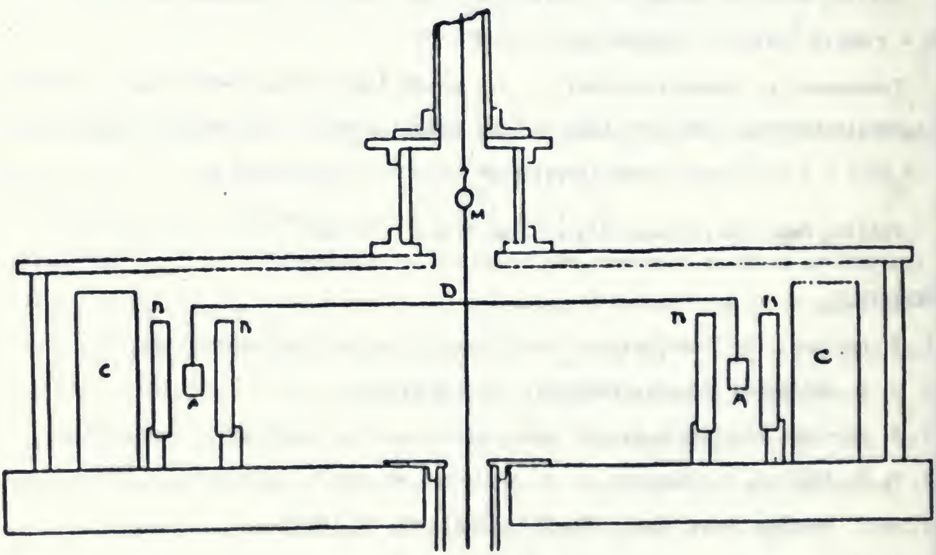

Fig. 3 (Fig. 2 is on the next page)

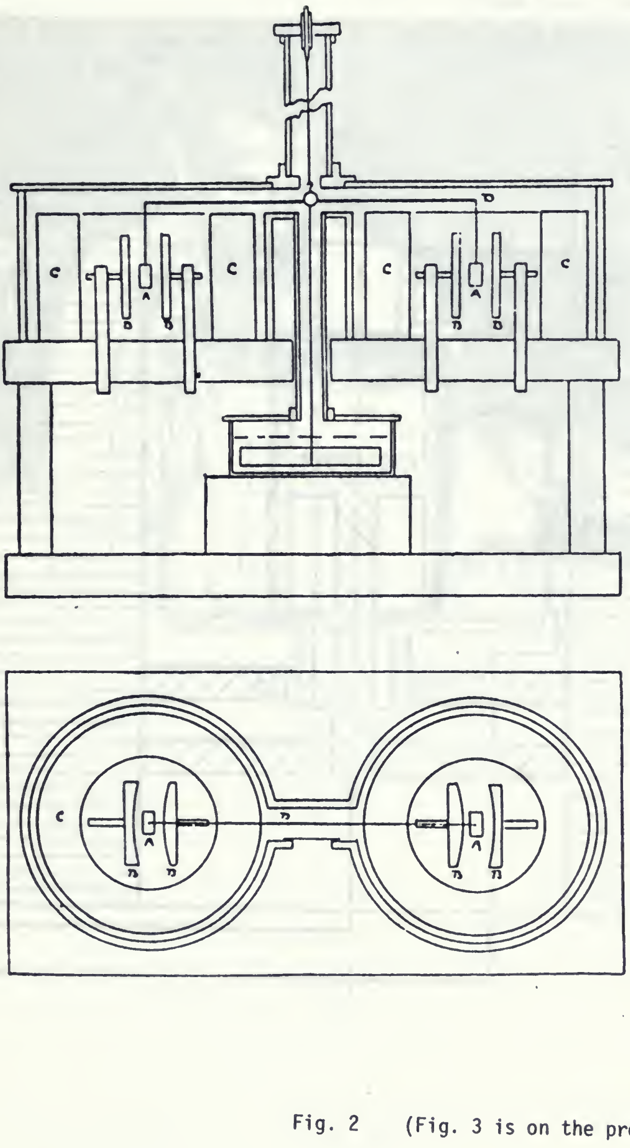

Fig. 2 (Fig. 3 is on the preceding page)

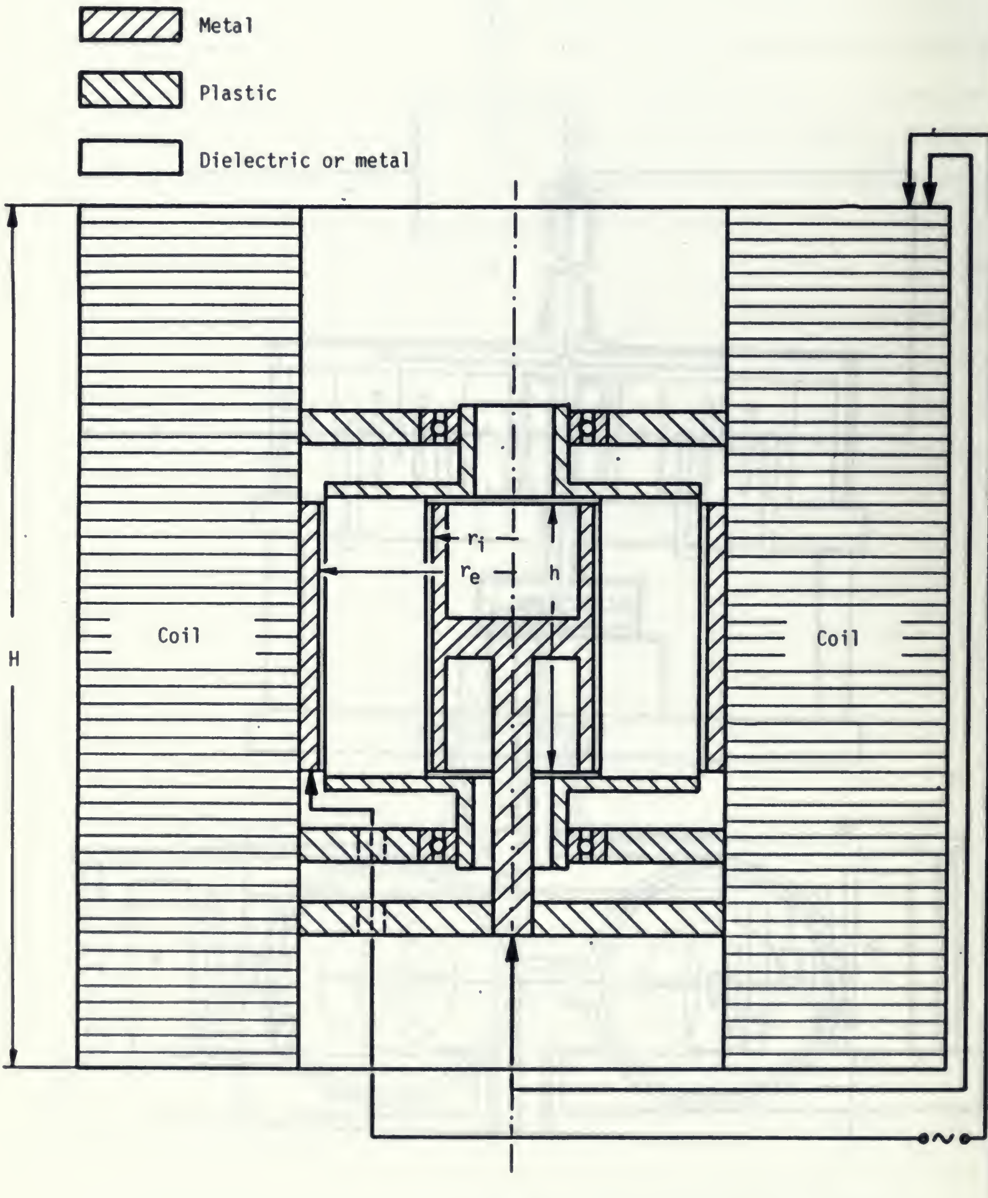

Fig. 4

Fig. 5

MAXWELL'S ILLUSION: THE DISPLACEMENT CURRENT

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Abstract. Giving a short historical survey, I show that the notion "displacement current" introduced by Maxwell has no physical substance. I show that both the displacement current in vacuum and the displacement current in dielectrics (the polarization current) neither generate magnetic field (i.e., do not act with potential forces on other currents) nor are sensitive to external magnetic fields (i.e., do not react with kinetic forces to the action of other currents). I pay special attention to the experiments which allegedly have verified the magnetic properties of displacement current and I show that in these experiments the measured effects were due to the magnetic action only of the conduction currents which supply electric charges to the plates of the condensers used in the experiments.

1. INTRODUCTION

At the very beginning I must emphasize that in this paper I shall consider only the potential electromagnetic fields and I shall ignore the radiation fields. Potential are the fields in which the electric intensity, $\mathbf{E}_{pot}$, and the magnetic intensity, $\mathbf{B}_{pot}$, are inversely proportional to the second power of the distance from the generating electric charges, while in the radiation fields the electric intensity, $\mathbf{E}_{rad}$, and the magnetic intensity, $\mathbf{B}_{rad}$, are inversely proportional to the first power of this distance being always equal one to another and mutually perpendicular. On the other hand, the potential fields depend on the positions of the charges and their velocities at the moment of observation, t_0, while the radiation fields depend on the positions of the charges and their accelerations at the advanced moment, $t' = t_0 - r/c$ (conventional physics wrongly calls t' retarded moment), where r is the distance from the charge generating the field to the reference point. Finally, the energy and momentum densities of the potential fields are null, while the energy and momentum densities of the radiation fields are different from zero

$$\varepsilon = (E_{rad}^2 + B_{rad}^2)/8\pi = E_{rad}^2/4\pi = B_{rad}^2/4\pi, \quad \mathbf{\Pi} = (1/4\pi c)\mathbf{E}_{rad}\times\mathbf{B}_{rad} = (1/4\pi c)E_{rad}B_{rad}\mathbf{n}, \quad (1)$$

where **n** is the unit vector along the direction of propagation of the radiation fields, and thus we have $\mathbf{\Pi} = \varepsilon \mathbf{n}/c$.

If the accelerations of the electric charges generating the fields are small, the radiation fields are very feeble and can be ignored. Any periodic electromagnetic system whose period is big enough can be considered as generating only potential fields. Such are, for example, the electromagnetic systems with period T = 0.02 sec,. i.e., with frequency ν = 50 Hz. More about the difference between potential and radiation electromagnetic fields see in Ref. 1.

The systems generating potential fields can be called quasi-stationary, while the systems generating also radiation fields can be called dynamic. Let me note that the systems in which the current densities are null (i.e., where the charges are at rest) are called static, and the systems in which the current densities are constant (i.e., in which the charges move with constant velocities along closed lines) are called quasi-static, or stationary.

Conventional physics makes a big error applying formula (1) also to the potential electric and magnetic fields. So if there is a permanent magnet producing the constant magnetic intensity **B** and a charged condenser producing the constant electric intensity **E**, according to conventional physics, there is an energy density in space given by the first formula (1) and a momentum density $\mathbf{\Pi} = (1/4\pi c)\mathbf{E}\times\mathbf{B} = (1/4\pi c)EB\sin(\mathbf{E},\mathbf{B})\mathbf{n}$. Thus, according to conventional physics, the system must continuously lose energy and to a wall put perpendicularly to the vector **n** a pressure

$$\mathbf{P} = \mathbf{f}/S = (d\mathbf{p}/dt)/S = \{(\mathbf{\Pi} S dr)/dt\}/S = \mathbf{\Pi}(dr/dt) = \mathbf{\Pi} c = \mathbf{E}\times\mathbf{B}/4\pi \qquad (2)$$

must act, where **f** is the force acting on the surface S, $d\mathbf{p}$ is the "momentum" of the potential electromagnetic field in the volume Sdr and dr is considered as certain differential distance such that dr/dt = c. It is clear to any child that all these conclusions of conventional physics are nonsense and idiotism, noting, however, that for a radiation electromagnetic field formula (2) is right, as in such a case dr is indeed the distance percoursed by the propagating electromagnetic field in a time dt.

In this paper I shall consider such systems of electric charges which generate only potential electric and magnetic fields.

2. MAXWELL'S DISPLACEMENT CURRENT

Before reading this paper, it will be good that the reader looks at Ref. 2 where I describe and define all different kinds of currents, namely the conduction current, the convection currents (Rowland and Röntgen currents) and the displacement currents (in vacuum and in dielectrics).

The motivations which brought Maxwell to the introduction of the notion "displacement current" were the following (I shall use in the quotation not Maxwell's but my notations to make the understanding of the matter easier, noting that the words in the parentheses are added by me):

In his magnum opus(3) Maxwell writes (p. 232):

> One of the chief pecularities of this treatise is the doctrine which asserts that the true electric current (density) $\mathbf{J}_{true}$, that on which the electromagnteic phenomena depend, is not the same thing as $\mathbf{J}$, the (density of the) current of conduction, but that the time variation of $\mathbf{D}$, the electric displacement, must be taken into account in estimating the total movement of electricity, so that we must note $\mathbf{J}_{true} = \mathbf{J} + (1/4\pi)\partial\mathbf{D}/\partial t$, which is the equation of true currents.

Just before this Maxwell writes(3) (p. 231):

> We have very little experimental evidence relating to the direct electromagnetic action of currents due to the variation of electric displacement in dielectrics, but the extreme difficulty in reconciling the laws of electromagnetism with the existence of electric currents which are not closed is one reason among many why we must admit the existence of transient currents due to the variation of the displacement. Their importance will be seen when we come to the electromagnetic theory of light.

Thus we see that Maxwell had not experimental grounds for the introduction of the displacement current and that he came to this notion on a pure speculative way. He found then some motivations for the "physical reality" of displacement current by analysing the propagation of electromagnetic waves (i.e., by analysing the light waves, as in Maxwell's time other electromagnetic waves were not known). Some authors assert that Maxwell has predicted the electromagnetic waves, i.e., the possibility for generating artificially electromagnetic radiation energy by using conduction currents, condensers and coils. This assertion is not true. Maxwells has only mathematically described the propagation of light waves, assuming that they might be electromagnetic waves. The first scientist who advanced the idea that an unclosed conduction current may radiate energy in space was FitzGerald[4] in 1883 (Maxwell died in 1879). H. Hertz was the first one[5] who in 1887 realized experimentally radiation of electromagnetic waves. Of course, Maxwell's assumption that light might be electromagnetic radiation was decisive for Hertz' discovery.

Conventional physics considers the existence of electromagnetic radiation as the most important confirmation of Maxwell's hypothesis that displacement current is a real current, generating potential magnetic field and reacting with kinetic forces to external magnetic fields. However one has not the right to make such a conclusion.

As a matter of fact, many important conclusions and results can be obtained proceeding from the principles of relativity and equivalence but the authenticity of these conclusions and results are not a proof of the veracity of the principles of relativity and equivalence, as we now know that these principles are not true. And what to say about the "laws" of conservation of energy, momentum and angular momentum. Almost all formulas which we write in our physics books are deduced on the basis of these "laws"; nevertheless, as was established now, at the end of the XXth century, these laws are not generally true.

Thus whether displacement current is a true current can be established only directly, i.e., by measuring its potential action and kinetic reaction.

This was clear to the founders of our present electromagnetic doctrines, as in 1879 Hermann Helmholtz announced a prize-question of the Prussian Academy of Sciences for the year 1882 (Ref. 6, p. 181):

> Die Akademie verlangt, daß entweder für oder gegen die Existenz der elektrodynamischen Wirkungen entstehender oder vergehender dielektrischer Polarisation in der von Maxwell vorausgesetzten Stärke, oder für oder gegen die Erregung dielektrischer Polarisation in isolierenden Medien durch magnetisch oder elektrodynamisch induzierte elektromotorische Kräfte entscheidende experimentelle Beweise gegeben werden.

This prize was awarded to H. Hertz for his indirect proof of the existence of displacement current in vacuum (air) when in the years 1886 - 1888, by the help of Maxwell's equations, he could mathematically describe the effects observed in his "electromagnetic waves" experiments. I think, however, that the prize of the Prussian Academy of Science must be awarded to Whitehead and to me, as Whitehead in 1903 demonstrated(7) that displacement currents do not react with kinetic forces to the action of other currents (Whitehead's experiment was repeated by me in an improved variation(2)) and I have demonstrated(8) that displacement currents do not act with potential forces on other currents, though, I must emphasize, the second kind of experiments can be never pure.

Concerning the second part of Helmholtz' prize-question, I have to say that nobody has succeeded until now to polarize dielectrics by the help of magnetic fields, meanwhile one can easily polarize a conductor by the help of magnetic fields.

That is the whole story about Maxwell's displacement current. A full point can be put here.

The rest of the article is dedicated to the clarification of certain aspects of displacement current which may remain puzzling to the reader.

3. THE "DISPLACEMENT CURRENT" TERM IN MAXWELL'S EQUATION

In his famous "Lectures on Physics" Feynman writes that in thousand years humanity will remember the XIXth century as the century in which Maxwell's equation have been written, meanwhile the American civil war will be mentioned only as a small local event of no importance for human history.

Maxwell's equations give the relations between the electric intensity, **E**, and the magnetic intensity, **B**, produced by a certain system of electric charges at a given reference point

$$\begin{aligned} \mathrm{rot}\mathbf{E} &= -(1/c)\partial\mathbf{B}/\partial t, \\ \mathrm{div}\mathbf{B} &= 0, \\ \mathrm{rot}\mathbf{B} &= \partial\mathbf{E}/c\partial t + (4\pi/c)\mathbf{J}, \\ \mathrm{div}\mathbf{E} &= 4\pi Q, \end{aligned} \tag{3}$$

where **E** and **B** are, by definition, the following functions of the electric potential, Φ, and the magnetic potential, **A**, generated by this system at the same reference point

$$\mathbf{E} = -\mathrm{grad}\Phi - \partial\mathbf{A}/c\partial t, \qquad \mathbf{B} = \mathrm{rot}\mathbf{A}, \tag{4}$$

From their part Φ and **A** are the following functions of the charge density, Q, and the current density, **J**,

$$\square \Phi = - 4\pi Q, \qquad \square \mathbf{A} = - (4\pi/c)\mathbf{J}, \qquad (5)$$

where $\square = \partial^2/\partial x^2 + \partial^2/\partial y^2 + \partial^2/\partial z^2 - \partial^2/c^2\partial t^2$ is the D'Alembert operator, as they are, by definition, the following functions of the charges, q_i, their velocities, $\mathbf{v}_i$, and their second proper distances to the reference point, r_{00i}, (the notion "second proper distance" is my notion)

$$\Phi = \sum_{i=1}^{n} q_i/r_{00i}, \qquad \mathbf{A} = \sum_{i=1}^{n} q_i\mathbf{v}_i/cr_{00i}, \qquad (6)$$

while Q and **J** are, by definition, the following functions of q_i, $\mathbf{v}_i$

$$Q(\mathbf{r}) = \sum_{i=1}^{n} q_i\delta(\mathbf{r} - \mathbf{r}_i), \qquad (\mathbf{r}) = \sum_{i=1}^{n} q_i\mathbf{v}_i\delta(\mathbf{r} - \mathbf{r}_i), \qquad (7)$$

where **r** is the radius vector of the reference point, $\mathbf{r}_i$ is the radius vector of the charge q_i, and δ( ) is the delta-function of Dirac.

The second proper distance r_{00i} for the case that the charge q_i moves with the velocity v along the x-axis and at the moment t = 0 is crossing the frame's origin, i.e., whose radius vector for t = 0 is $\mathbf{r}_i = 0$, is given by the following formula

$$r_{00i} = |\mathbf{r} - \mathbf{r}_i| = \{(x - vt)^2 + (1 - v^2/c^2)(y^2 + z^2)\}^{1/2}. \qquad (8)$$

Indeed, by the help of formula (8), the following mathematical relation can be easily verified (see Ref. 1, p. 30)

$$\square(1/r_{00i}) = - 4\pi\delta(\mathbf{r} - \mathbf{r}_i), \qquad (9)$$

so that multiplying this identity, respectively, by q_i and $q_i\mathbf{v}_i$ and summing over the number n of all charges of the system, we shall obtain (5) if we take into account the definition equalities (6) and (7).

One sees immediately that the first pair of the Maxwell equations (3) is a trivial mathematical result of the definition equalities (4). In Ref. 1, p. 30, I give the childishly simple calculations by whose help one obtains the second pair of the Maxwell equations (3) from equations (4) and (5).

Thus "Maxwell's theory" (according to Hertz, Maxwell's theory are the Maxwell equations) IS A COUPLE OF MATHEMATICAL TRIVIALITIES. If something needs discussion, this is only equation (8) which is a result of the Marinov-aether character of light propagation (if light would have a Newton-aether character of propagation, we should have instead of relation (8) the following relation $r_{\dagger} = \{(x - vt)^2 + y^2 + z^2\}^{1/2}$).

Let us now turn our attention to the first term on the right side of the third Maxwell equation (3), the so-called "displacement current" term. In Ref. 8, p. 323 I give the physical interpretation of this term. $(1/4\pi)\partial\mathbf{E}/\partial t$ is not some current density generating magnetic field, as Maxwell supposed. This term gives information about the conduction currents which have been interrupted in the neighbourhood of the reference point Indeed, integrating the third Maxwell equation (3) over a certain surface S bounded by the closed line L and using Stokes theorem, we shall have

$$\int_L \mathbf{B}.d\mathbf{l} = (1/c)\partial/\partial t \int_S \mathbf{E}.d\mathbf{s} + (4\pi/c)\int_S \mathbf{J}.d\mathbf{s}. \qquad (10)$$

If there is no conduction current interrupted by the surface S, the first integral on the right side is zero and equation (10) will say that the quantity of electric current crossing the surface S, multiplied by $4\pi/c$, is equal to the line integral of the magnetic intensity **B** along the boundary L of the surface S. But if surface S interrupts conduction currents, these interrupted currents will also have some contribution to the magnetic intensity along the boundary L. The contribution of these interrupted currents is given by the term $(1/c)\partial/\partial t \int \mathbf{E}.d\mathbf{s}$. As the interrupted currents do not cross the surface S, the time variation of the electric intensity at the points of this surface, which electric intensity is generated by the opposite charges delivered by the interrupted currents on both sides of S, gives information on the quantity of the interrupted currents.

That is all about the "displacement current" term in Maxwell's equation and no word anymore is to be added. If a word is to be added than only one: All those who have annouced of having measured the magnetic field produced by displacement currents (see beneath have measured exactly the field of the interrupted conduction currents AND NOTHING ELSE.

4. THE DISPLACEMENT CURRENT IN VACUUM

One discusses in the literature only the problem whether the displacement current in vacuum generates potential magnetic field. Obviously, even for the most dogmatic Maxwellians, it is clear that one is unable to discuss the problem whether the displacement current in vacuum can react with kinetic forces to the action of other currents, as vacuum has no mass and thus even God is unable to set vacuum in motion. Thus one part of the Maxwellians (the most stupid ones) sustain the opinion that the displacement current in vacuum can set in motion external currents, forgetting Newton's third law and leaving without discussion the problem whether the external currents can set the vacuum in motion[11,12]. The more clever Maxwellians sustain the opinion that the displacement current in vacuum does not generate magnetic field. I shall cite only Planck[13]:

> ... even in the case of unclosed currents the magnetic intensity of the field is calculated from the vector potential of the conductions currents without regard to the displacement current.

I shall mention the names of other authors who more or less share Planck's opinion: Warburton[14], French and Tessman[15] (who give an excellent example with a charged condenser where the air between the plates becomes ionized by an x-ray source; the moving ions which neutralize the charges on the plates present electric current and generate magnetic field, however the displacement current $(1/4\pi)\partial E/\partial t$ does not generate an additional (equal and opposite) field), Whitmer[16] (not clear enough position), Purcell[17] (one of the most categoric assertion that displacement current in vacuum does not generate magnetic field), Rosser[18].

And let me cite two of the most authoritative textbook-writers who sustain the opinion that the displacement current in vacuum does generate magnetic field: Mie[19] and Bergmann-Schaefer[20]. It is curious to note that while French and Tessman[15] sustain the opinion that a leaky condenser does generate magnetic field (see above), Mie sustains the opposite opinion, namely that the magnetic field of a leaky condenser is null, as the conduction and dispalcement currents are equal and oppositely directed. - Милое семейное недоразумение в клане герольдов замкнутых токов.

5. THE DISPLACEMENT CURRENT IN DIELECTRICS (THE POLARIZATION CURRENT)

The Maxwellians are in disaccord about the potential magnetic action of displacement current in vacuum and evade to discuss the problem about the kinetic reaction of the vacuum to external currents. However ALL OF THEM affirm that the displacement current in dielectrics (which I shall call further, for shorteness, also polarization current) has both the potential and kinetic characteristics of conduction currents. I have not found single textbook where some contrary opinion would be expressed.

Meanwhile, polarization current, exactly as the displacement current in vacuum, neither acts with magnetic forces on other currents nor reacts with kinetic forces to the magnetic action of other currents.

6. THE EXPERIMENTAL EVIDENCE AGAINST MAXWELL

In the history of physics there are only three experiments which give clear answers that the polarization current is no current. My potential displacement current experiment(2) showed that polarization current does not generate magnetic field. Whitehead's kinetic displacememt current experiment(7) showed that polarization current does not react with kinetic forces to the action of other currents. My kinetic displacement current experiment(2) which was an improved repetition of Whitehead's experiment confirmed Whitehead's observations.

Of course, my experiments violating Newton's third law (see Sect. 8) can also be considered as experimental evidence against Maxwell.

Now I shall shortly mention how was Whitehead's historic experiment accepted by the scientific community in his time. Kolacek(21) begins his analysis of Whitehead's experiment with the following words:

> Unter dem Titel "Über die magnetische Wirkung elektrischer Verschiebung" von John B. Whitehead jr., erschien in dieser Zeitschrift (**4**, 229, 1903) eine Abhandlung, in welcher sorgfältige Versuche beschrieben werden, deren Resultate für die Maxwellsche Lehre vom elektromagnetischen Felde verhängnisvoll werden könnten, wenn si sich nicht anders interpretieren ließen als durch Nichtwirkung des Magnetfeldes auf Verschiebungsströme.

Kolacek writes further:

> Im Whiteheadschen Arrangement ließ sich unter der Voraussetzung, daß die Verschiebungsströme allein die Ursache des Antriebs sind, die Stärke desselben berechnen. Dieselbe hätte eine Drehung im Betrage von 485 Skalenteilen ergeben müßen, während tatsächlich das Beobachtungsresultat negativ war.
> Dies ist, wie im folgenden gezeigt werden soll, in bester Übereinstimmung mit den Maxwell-Faradayschen Anschauungen...

I leave the reader to read alone Kolacek's unclear paper, as I never lose my time for a discussion with people who try to explain why the "white" is "black". I should like only to note that Kolacek's conclusions are exactly of the same style as Dr. Maddox' conclusion[22] on the results of my "coupled shutters" experiment with whose help I measured the Earth's absolute velocity by an optico-mechanical experiment in the closed laboratory:

> Marinov claims that his results, most recently obtained with home-made equipment at Graz, demonstrate that the velocity of light is not the same in all directions. He even claims to have been able to detect the velocity and direction of the Earth's movement through absolute space and time.
> None of this proves that there is anything wrong with special relativity.

Then Gans[23] gave another "explanation" why the null result in Whitehead's experiment was to be considered not as a disproof of Maxwell's concepts but as their confirmation. According to Gans, besides the magnetic action of electric displacement current, there is an equal and opposite "electric action" of a certain "magnetic displacement current". *Voila* a glittering citation from Gans's paper:

> Hierzu kommt - und das hat Herr Whitehead vergessen - noch die elektrische Wirkung magnetischer Verschiebungsströme.

I do not suggest to the reader to look for Gans' paper in *Physikalische Zeitschrift*. The name of the author itself is a sifficient argument to explain why.

7. THE ALLEGED EXPERIMENTAL EVIDENCE IN FAVOUR OF MAXWELL

Before beginning with the analysis of the experiments whose executors claimed of having revealed the magnetic properties of polarization current, I should like to cite once more Maxwell to show to the reader clearly that these properties of the polarization current have been introduced by Maxwell on a purely speculative ground without any reference to experimental evidence (as I already did in Sect. 2). So in a paper published in 1868 Maxwell writes[24]:

> According to this view, the current produced in discharging a condenser is a complete circuit, and might be traced within the dielectric itself by a galvanometer properly constructed. I am not aware that this has been done, so that this part of the theory, though a natural consequence of the former, has not been verified by direct experiment. The experiment would certainly be a very delicate and difficult one.

I should like to add only the following remark to the last part of the above Maxwell's statement: In the XIXth century when dielectrics with high permittivity were unknown, the execution of experiments for showing whether polarization current has or has not magnetic properties could be a difficult technological problem, but today when dielectrics with permittivities ten thousands of times bigger than that of air are available, even children can mount experiments to show that the polarization current is not current.

All experiments which allegedly have verified Maxwell hypothesis about the magnetic properties of displacement current (in dielectrics and in vacuum) were potential experiments, in which the magnetic action of the displacement current on other currents was searched for. There is no single kinetic experiment in which the magnetic reaction of displacement currents to the action of other currents has been observed.

As in the first kind of experiments the potential magnetic action caused by the conduction currents which deliver electric charges to the plates of the condenser (between whose plates the displacement current flows) can be not excluded, this first kind of experiments are not pure and if one should not take into account this action, one can wrongly ascribe the effects observed to the alleged magnetic action of the displacement current. As I shall show now, this was the case in all reported experiments.

It is logical to expect that nobody of the Maxwellians was able to report on kinetic displacement current experiments, which are pure, as the dielectric in which polarization currents flow can be not set in motion by magnetic fields.

The alleged potential displacement current experiments with positive outcome are also three:

A. Eichenwald's experiment[25] (improvement of Röntgen's experiment[26]).

The first of Eichenwald's papers[25] (p. 1) is dedicated to the observation of the magnetic action of Rowland's currents and the first part of the second paper[25] (p. 421) is dedicated to the observation of the magnetic action of Röntgen's currents. The part dedicated to the alleged observation of the magnetic action of displacement currents begins from p. 434.

The principal scheme of Eichenwald's experiment is given in fig. 1. A disk of dielectric S (rubber with $\varepsilon = 3$) can rotate between two parallel condenser plates which are divided in two half-circular plates 1, 2 and 3, 4. It is shown in fig. 1b how the four half-circular plates are connected to the source of electric tension (about 10,000 V).

Thus the two halves of the rubber disk will be oppositely polarized, as it is shown in fig. 1b. When the disk rotates between the condenser's plates, at the transition from plates 1, 2 to plates 3, 4, the polarization direction will be inverted. Consequently, according to Maxwell, a polarization current will flow in parallel to the axis of rotation. The potential action of this "polarization current" was observed by Eichenwald on the deviation of a sensitive magnetic needle. And Eichenwald has even shown, by comparison of theory with observations, that only the polarization current has a magnetic action but the displacement current in vacuum has not, as, according to Eichenwald, the effect observed was proportional not to $\varepsilon\partial E/\partial t$ but to $(\varepsilon - 1)\partial E/\partial t$.

All what Eichenwald has calculated was a pure nonsense. If Eichenwald had put a galvanometer in the circuit of the condenser, he would have seen that by increasing the applied potential and by increasing the rate of rotation (see Eichenwald's table on p. 439) the current in the circuit will increase. His magnetic needle was displaced under the magnetic action of this conduction current.

I have easily observed such effects of increase of the current in the circuit of the condenser at an increase of the tension and of the rate of rotation in a plexiglas disk described and photographed on p. 22 of Ref. 27.

B. Whitehead's INDUCTION experiment[28] (improvement of Thompson's experiment[29]).

Although Whitehead has carried out in 1903 his EXCELLENT kinetic displacement current experiment[7], showing the inconsistency of Maxwell's concepts, in 1905 he published the report on a potential displacement current experiment in favour of Maxwell's concepts.

I am perplexed why Whitehead has surrendered. Have been Kolacek[21] and Gans[22] able to persuade him that the null result of his kinematic experiment was to be considered as a confirmation of Maxwell's concepts? - Whitehead is dead and nobody can give the answer. The professors once more have strangled the scientific truth.

Whitehead's INDUCTION experiment[28] is shown in fig. 2. A dielectric A in a parallel-plate condenser B-B is encircled by a ring of laminated iron C-C, on which a ring-coil is wound. Through the condenser an alternating current with frequency 133 Hz and tension 25,000 V was conducted. In the circuit of the ring-coil a vibrational galvanometer G was inserted which showed the intensity of the induced alternating current. Whitehead calculated that the induced current was exactly equal to this one which had to be induced from the alternating displacement current on the track B-B, without taking into account the magnetic action of the conduction current in the wires supplying the charges to the plates of the condenser. Meanwhile, exactly the potential action of this conduction current was the cause for the indications of the galvanometer. Whitehead has neither measured this current nor mentioned it. This important omission was noted also by Mie[19]

> Die Kapazität des Kondensators (Fläche 1164 cm^2, Dicke des Dielektrikums 20 cm, $\varepsilon = 2.0$ für Paraffin) läßt sich schätzungsweise auf 1.03×10^{-11} F berechnen, es ist danach ein Strom von etwa 2×10^{-4} A effektiv zu erwarten, merkwürdigerweise wurde er nicht gemessen, soweit man aus den Angaben sehen kann.

Whitehead has done the experiment with paraffin ($\varepsilon = 2$) and air ($\varepsilon = 1$). In the second case, according to his theory, the indication of the galvanometer had to be two times lower, however, as his table on p. 477 shows, it was less than twice lower. The reason was only one: The condenser with air had a lower capacitance and for this reason the current in the circuit was lower. If Whitehead had measured the current in the circuit of the condenser, he would have seen that the ratio of the currents going through the vibrational galvanometer G would be exactly equal to the ratio of the currents in the circuit of the condenser.

The essence of Whitehead's induction experiment will become entirely clear after the reading of item C.

C. The Bartlett and Corle experiment[11].

I have already analysed the Bartlett and Corle experiment in Ref. 8, so that I shall shortly repeat what was written there.

Bartlett and Corle have measured the magnetic intensity at different points along the radius of the circular cross-section between the plates of a circular parallel-plate condenser charged by an alternating current (fig. 3). The observed values are plotted in fig. 4.

The theoretical graph can be predicted proceeding in two different ways:

1) Calculating the magnetic potential generated by every of the conduction current elements, summing and using the second formula (4) for obtaining the net magnetic intensity, which can be called the Biot-Savart way.

2) Using Maxwell's equation (10), which can be called the Maxwell way.

Let us follow both these ways.

1) Biot-Savart's way. Let us have a wire of length d and let us find the magnetic potential at a distance r from the middle of the wire if current I flows along it. According to the definition equality (6), the magnetic potential generated by a current element $I\mathbf{dr}$ (dr is a linear element of the wire directed along the current's direction) at a distance r from it is $\mathbf{A} = I\mathbf{dr}/cr$. Thus for the magnetic potential of our straight wire we shall have, taking the x-axis parallel to the wire pointing along the current direction, its origin at the middle of the wire, the y-axis pointing to the reference point, and considering the magnetic potential of the whole wire as twice the potential generated by its right half,

$$\mathbf{A}_d = (2I/c)\int_0^{d/2}(x^2+y^2)^{-1/2}\,dx\,\hat{\mathbf{x}} = (2I/c)\mathrm{Arsinh}(d/2y)\,\hat{\mathbf{x}}. \qquad (11)$$

For the magnetic intensity, at a point on the positive y-axis, according to the definition equality (4), we shall have

$$\mathbf{B}_d = \mathrm{rot}\mathbf{A}_d = (2Id/cy)(d^2+4y^2)^{-1/2}\,\hat{\mathbf{z}}. \qquad (12)$$

Thus the magnetic intensity generated by an infinitely long wire, at a distance y = r, will be

$$\mathbf{B}_\infty = (2I/cy)\hat{\mathbf{z}}. \qquad (13)$$

Let us now consider an infinitely long wire which is interrupted in the middle by a capacitor, the distance between whose circular plates is d. The magnitude of the magnetic intensity at a point distant r from the central point of the axis of the capacitor will be

$$B = B_\infty - B_d = (2I/cr)\{1 - d(d^2+4r^2)^{-1/2}\} \cong 4Ir/cd^2, \qquad (14)$$

where the result on the right side is written for $d \gg r$.

At this deduction the radius R of the circular plates of the condenser was not taken into account. Thus formula (14) is valid for $d \gg R$.

2) Maxwell's way. Let now see which result will be obtained if we shall use Maxwell's equation (10). Taking the surface S as a circle with radius r and center at the middle point of the condenser's axis, we shall obtain, assuming $d \ll R$,

$$B\oint_0^{2\pi r} dl = (1/c)(\partial E/\partial t)\int_0^r 2\pi r'\,dr', \qquad (15)$$

so that, taking into account that $E = U/d$, where $U = U(t)$ is the tension between the condenser's plates at time t, and that $\partial U/\partial t = (1/C)\partial q/\partial t = I/C$, where $q = q(t)$ is the quantity of electric charge on one of the plates, $I = I(t)$ is the current flowing in the conducting wires and $C = R^2/4d$ is the capacitance of the condenser, we obtain

$$B = \frac{2I}{cr}, \quad \text{for } r > R, \qquad\qquad B = \frac{2Ir}{cR^2}, \quad \text{for } r < R. \tag{16}$$

When comparing formulas (14) and (16) one must always keep in mind that (14) was deduced at the condition $d \gg R$, while (16) at the condition $d \ll R$.

It is logical to assume that also for d of the same order as R the Biot-Savart's and Maxwell's ways will lead to identical results, however the calculations in such a case along both ways are horrible.

Let us now see where will lead us the Biot-Savart's and Maxwell's ways if the space between the condenser's plates will be filled with a dielectric with permittivity ε.

The availability of dielectric changes nothing in the Biot-Savart's calculations, as when looking from the conduction currents view-point the redistribution of the electric intensity in space is of no importance.

To make the Maxwell's calculations, we must write the equations (3) and (10) at the availability of dielectric in the form

$$\mathrm{rot}\mathbf{B} = (\varepsilon/c)\partial\mathbf{E}/\partial t + (4\pi/c)\mathbf{J}, \tag{17}$$

$$\oint_L \mathbf{B}.d\mathbf{l} = (\varepsilon/c)\partial/\partial t \int_S \mathbf{E}.d\mathbf{s} + (4\pi/c)\int_S \mathbf{J}.d\mathbf{s}. \tag{18}$$

Now the electric intensity, **E**, in the dielectric will be very feeble, but the product $\varepsilon\mathbf{E} = \mathbf{D}$ which is the electric displacement, **D**, will be quasi equal to the electric intensity when there is NO dielectric. The electric intensity in the space outside of the condenser will be slightly changed with respect to this when there is no dielectric. Thus the calculation of **B** according to formula (18) will lead to the same result which should be obtained for the case when there is vacuum between the plates.

Hence we have to conclude that Maxwell's equations are not wrong. Wrong is only Maxwell's interpretation of the displacement current!

Some of the Maxwellians following the wrong Maxwell's interpretation of the displacement current make also computational errors. So instead to agree that the calculation of B by the help of formula (18) will lead to the same value for $\varepsilon = 1$ and for $\varepsilon \neq 1$, they make the calculation with $\varepsilon > 1$ in the following wrong way.

Let assume, say such Maxwellians, that ε is very high (assuming for simplicity ε tending to infinity). Then one should have the whole electric field concentrated in the dielectric and outside the dielectric the electric field will be zero. Thus one can limit the integration in the integral on the right side of (15) from 0 to R, so that this equation should be written

$$B \oint_0^{2\pi r} dl = (\varepsilon/c)(\partial E/\partial t) \int_0^R 2\pi r' dr' . \qquad (19)$$

Putting here

$$\partial E/\partial t = (1/d)\partial U/\partial t = (1/dC)\partial q/\partial t = I/dC = 4I/\varepsilon R^2, \qquad (20)$$

such Maxwellians obtain again the results (16). However now the case is substantially different, as we do not pose the condition $d \ll R$, and the Maxwellians wrongly conclude that if the same current flows in the conducting wires, then the magnetic intensity will be independent of the length, d, between the plates of the condenser (I repeat, at ε tending to infinity). Thus for such Maxwellians the displacement current flowing in the dielectric generates exactly the same magnetic intensity as if the plates should be connected by a wire. Such calculations of the Maxwellians are wrong, as formula (20) is wrong. Indeed, at the availability of dielectric one has to write on the left side of (20) not $\partial E/\partial t$ but $\partial D/\partial t$, and thus one should obtain $B = 2I/c\varepsilon r$, what at $\varepsilon \to \infty$ leads to $B \to 0$. Obviously, for $\varepsilon \to \infty$, the formula for C loses its sense.

The right approach in this case is the following. As any quantity of electric charge q which comes to the one condenser's plate "binds" exactly the same quantity of opposite charge on the other plate, then taking into account that on the one plate the charge is q and on the other -q, the relation between charge and tension will be $U = 2q/d$ and we shall have

$$\partial D/\partial t = (1/d)\partial U/\partial t = (2/d^2)\partial q/\partial t = 2I/d^2. \qquad (21)$$

Putting this in (19), we shall find remembering that when $\varepsilon \to \infty$, then $D = 0$ for $r > R$,

$$B = \frac{IR^2}{crd^2}, \quad \text{for } r > R, \qquad B = \frac{Ir}{cd^2}, \quad \text{for } r < R. \tag{22}$$

I should like to point out at the difference between the electric intensity, **E**, and electric displacement, **D**, which are connected by the relation **D** = ε**E**, and the magnetic intensities **B**, **H**, which are connected by the relation **B** = μ**H**, where μ is the permeability of the medium. In vacuum I denote the magnetic intensity by **B** (and not by **H**, as many authors do). At the availability of magnetics, although I do not wish, I call **B** magnetic induction, as so the whole world does. According to me, however, the name magnetic intensity is to be preserved for **B**, while **H** must be called by some other name.

There are many parallels between **E**, **D**, on one side, and **H**, **B**, on the other, but there are also many differences. The fundamental difference is that dielectrics make only redistribution of the electric intensity, while magnetics generate new magnetic intensity.

The following example will make this difference very clear. Let us have a point electric charge q. The electric intensity in vacuum, at a distance r from it, will be $\mathbf{E} = -q\,\mathrm{grad}(1/r) = q\mathbf{r}/r^3$. If we put this charge in a dielectric with permittivity ε, and we cut a thin spherical shell in the dielectric with a radius r, the electric intensity in the shell will be exactly the same, as when there is no dielectric. If, however, there is a long enough solenoid with nI ampere-windings on a unit of length, the magnetic intensity will be $H = (4\pi/c)nI$ in the solenoid and $H = 0$ outside. When putting this solenoid in a magnetic with permeability μ, the magnetic intensity, i.e., the magnetic induction, in a thin slice cut in the solenoid's magnetic in parallel to its axis will be $B = (4\pi/c)\mu nI = \mu H$ and will be thus μ times bigger than in the case where there is no magnetic.

For this reason I evade, as far as possible, to use two different symbols and two different terms for B and H, as the magnetization of the magnetics leads to "creation" of additional ampere-windings. But I always use two different symbols and two different names for **D** and **E**, as the polarization of the dielectrics does not lead to the "creation" of new free electric charges.

8. VIOLATION OF NEWTON'S THIRD LAW

The reader may object that I lose too much time to explain the misconcepts of the Maxwellians, as the problems seem to be tiny. Hundred years mankind operates with the notion "displacement current" and the electromotors rotate, the generators generate and the antennas radiate energy. And nobody has found a certain contradiction between experiments and concepts (let us ignore some minor errors of certain authors as that one pointed at the end of section 4).

The reason is that NOBODY has tried to observe the KINETIC interaction between loops with large distances between the condener's plates filled with dielectrics with high permittivity. As there is NO displacement current, such circuits are UNCLOSED. And as Newton's third law is not preserved for unclosed loops, one can realize violations of the laws of conservation of momentum and angular momentum. Such violations present some of the MOST IMPORTANT EFFECTS discovered in the history of physics.

I have twice observed violations of the law of angular momentum conservation: with my Bul-Cub machine without stator[30] and with my Rotating Ampere Bridge with Displacement Current[1] (p. 126).

I am unable to bring my papers to the attention of the scientific community, as the editors of the physical journals, under the command of the hardy Sir John from NATURE, consider my attacks against Newton, Maxwell and Einstein as lese-majesty. But once when the *Steinmauer* in physics will obtain a breach, as the one in Prussia, the scientific dogmas will sink down in the flood of experimental truth.

REFERENCES

1. S. Marinov, The Thorny Way of Truth, Part IV, (East-West, Graz, 1989), p. 68.
2. S. Marinov, The Thorny Way of Truth, Part VII, (East-West, Graz, 1989), p. 26.
3. J. C. Maxwell, A Treatise on Electricity and Magnetism (Oxford University Press, Oxford, 1873).
4. G. F. FitzGerald, Report on the 53rd Meeting of the British Association, 1883, p. 405. Reprinted in the Scientific Writings of G. F. FitzGerald, ed. J. Larmor, Dublin/London, 1902, p. 129.
5. H. Hertz, Annalen der Physik und Chemie, N.F. **31**, 421 (1887).
6. W. Kaiser, Theorien der Elektrodynamik im 19. Jahrhundert; arbor scientiarum: Beiträge zur Wissenschaftsgeschichte (Herausgeber: O. Krätz, W. Salter, H.-W. Schütt, C. J. Scriba). Reihe A: Abhandlungen, Band VIII (Gerstenborg Verlag, Hildesheim, 1981).
7. J. B. Whitehead, Physikalische Zeitschrift, **4**, 229 (1903). (The paper is reproduced in Ref. 2, p. 67.)
8. S. Marinov, The Thorny Way of Truth, Part I (East-West, Graz, 1988), p. 317.
9. S. Marinov, Eppur si muove (C.B.D.S., Bruxelles, 1977), p. 50.
10. S. Marinov, Classical Physics (East-West, Graz, 1981), vol. V, p. 20.
11. D. F. Bartlett and T. R. Corle, Physical Review Letters, **55**, 59 (1985). (The paper is reproduced in Ref. 1, p. 208). See also D. F. Bartlett et al., Phys. Rev. A, **39**, 938 (1989).
12. J. Maddox, Nature, **316**, 101 (1985). (The paper is reproduced in Ref. 2, p. 158.)
13. M. Planck, Introduction to Theoretical Physics (MacMillan Ltd., London, 1932), vol. III, p. 197.
14. F. W. Warburton, American Journal of Physics, **22**, 299 (1954). (The paper is reproduced in Ref. 2, p. 134.)
15. A. P. French and J. R. Tessman, American Journal of Physics, **31**, 201 (1963). (The paper is reproduced in Ref. 2, p. 141.)
16. R. M. Whitmer, American Journal of Physics, **33**, 481 (1965). (Reproduced in Ref. 2, p. 151.)
17. E. M. Purcell, Elektricity and Magnetism, Second Volume of Berkley's course on Physics (McGraw-Hill, New York, 1965), p. 195. (The paper is reproduced in Ref. 2, p. 132.)

18. W. G. V. Rosser, American Journal of Physics, **44**, 1221 (1976). (The paper is reproduced in Ref. 2, p. 155.)

19. G. Mie, Elektrodynamik, Vol. 11 of Handbuch der Experimentalphysik, edited by W. Wien und F. Harms (Akademische Verlagsgesellschaft, Leipzig, 1932), p. 62. (Reproduced in Ref. 2, p. 118.)

20. Bergmann-Schaefer, Lehrbuch der Experimentalphysik, Band II, Elektrizität und Magnetismus (Walter de Gruyter, Berlin, 1971), p. 230. (Reproduced in Ref. 2, p. 127.)

21. F. Kolacek, Physikalische Zeitschrift, **5**, 45 (1904). (Reproduced in Ref. 2, p. 73.)

22. J. Maddox, Nature, **316**, 209 (1985). (The paper is reproduced in: S. Marinov, The Thorny Way of Truth, Part II (East-West, Graz, 1986), p. 311.)

23. R. Gans, Physikalische Zeitschrift, **5**, 162 (1904).

24. J. C. Maxwell, Philosophical Transaction of the Royal Society, London, p. 158 (1868).

25. A. Eichenwald, Annalen der Physik, **11**, 1 and 421 (1903). (Reproduced in Ref. 2, p. 84.)

26. W. C. Röntgen, Sitzungsberichte der k. Akademie der Wissenschaften zu Berlin, p. 195 (1885); Rep. der Physik **21**, 521 (1885).

27. S. Marinov, The Thorny Way of Truth, Part V (East-West, Graz, 1989).

28. J. B. Whitehead, Physikalische Zeitschrift, **6**, 474 (1905). (The paper is reproduced in Ref. 2, p. 77.)

29. S. P. Thompson, Proceedings of the Royal Society, **45**, 392 (1889).

30. S. Marinov, The Thorny Way of Truth, Part III (East-West, Graz, 1988), p. 48.

FIGURE CAPTIONS

Fig. 1. Eichenwald's experiment.

Fig. 2. Whitehead's INDUCTION experiment.

Fig. 3. Scheme for Bartlett and Corle and for Marinov potential displacement current experiments.

Fig. 4. Results of Bartlett and Corle experiment. BP = bottom of plates, C/L = center line, TP = top of plates.

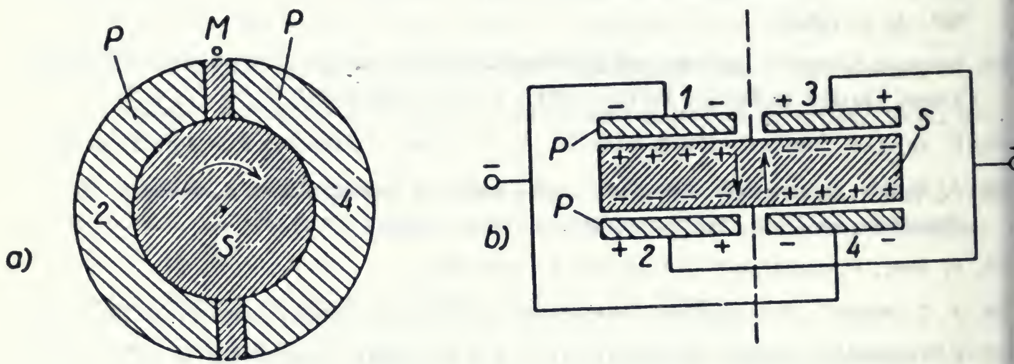

Fig. 1

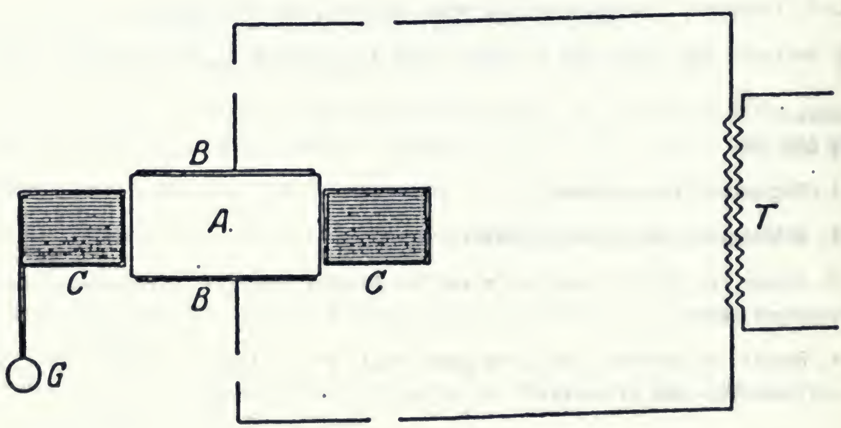

Fig. 2

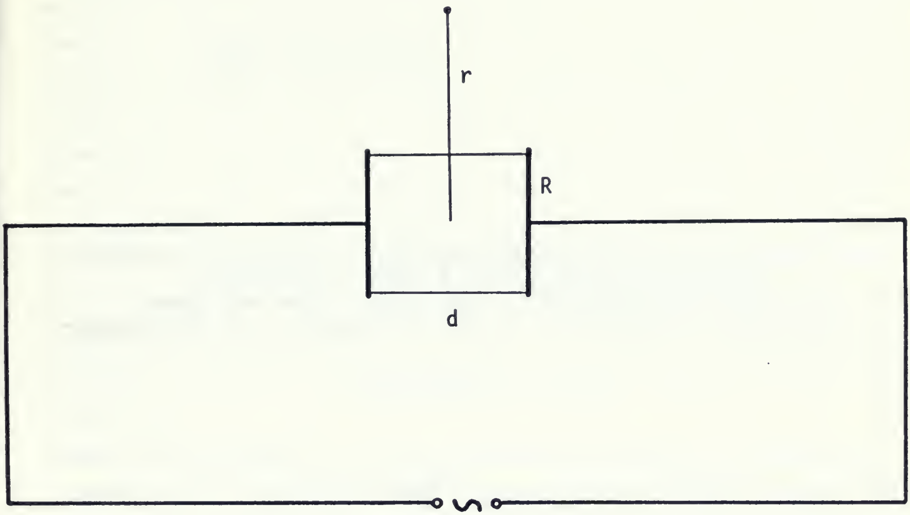

Fig. 3

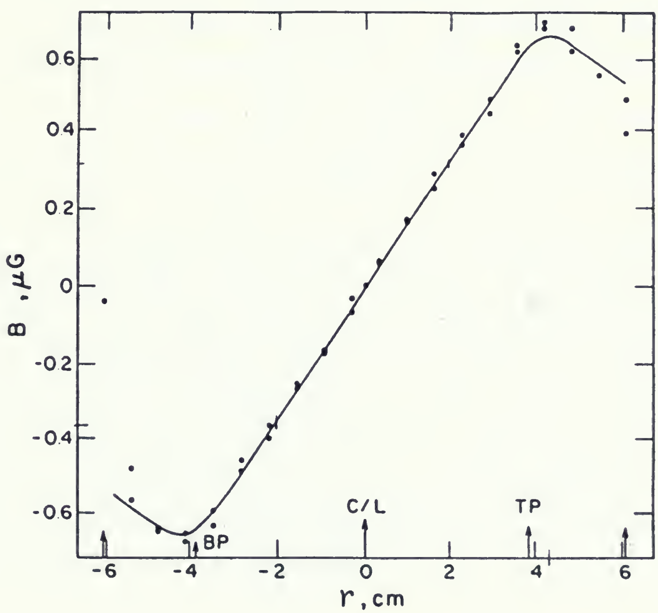

Fig. 4

JOURNAL DE PHYSIQUE
VOL. 1, P. 8 (1902)

SUR L'ABSENCE DE DÉPLACEMENT ÉLECTRIQUE, LORS DU MOUVEMENT D'UNE MASSE D'AIR DANS UN CHAMP MAGNÉTIQUE; ET SUR LA NON-EXISTENCE D'UNE ACTION D'UN TEL CHAMP SUR UNE MASSE D'AIR QUI EST LE SIÈGE D'UN COURANT DE DÉPLACEMENT;

Par M. R. BLONDLOT.

Les théories que Hertz, d'une part, et H.-A. Lorentz, d'autre part, ont données de l'Électrodynamique pour les corps en mouvement, affirment l'une et l'autre que, lorsque dans un champ magnétique, on fait mouvoir une masse isolante normalement aux lignes de force du champ, il se produit dans cette masse un déplacement analogue à celui dont Faraday et Maxwell admettent l'existence dans le diélectrique d'un condensateur. Toutefois ces deux théories ne lui assignent pas la même valeur : le déplacement d'après Lorentz est égal au déplacement d'après Hertz multiplié par le facteur $\frac{K - K_0}{K}$, où K représente le pouvoir inducteur spécifique du diélectrique en mouvement, et K_0 celui du vide [1]. Il résulte de là que, d'après Lorentz, lorsque le diélectrique en mouvement est de l'air, le déplacement doit être nul, au lieu d'avoir une valeur finie, comme l'indique la théorie de Hertz. On voit donc que l'étude expérimentale du déplacement dans le cas de l'air donne le moyen de décider entre les deux théories : c'est ce qui m'a engagé à l'entreprendre.

Afin de décrire plus aisément la méthode que j'ai employée, je me servirai d'un système de coordonnées rectangulaires dont l'axe OZ sera supposé vertical. Un champ magnétique uniforme a ses lignes de force dirigées parallèlement à OX et dans le même sens ; d'autre part, un courant d'air est lancé dans ce champ dans la direction et le sens de OZ.

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(1) H. Poincaré, *Électricité et Optique*, 2e édition, p. 499.

D'après la règle de Fleming, il résulte de ce mouvement une force électromotrice dirigée dans la direction et le sens des y négatifs. Imaginons maintenant que l'on ait disposé dans le champ un condensateur formé de deux plaques métalliques parallèles à XOZ, et reliées entre elles par un fil de métal. Si l'air en mouvement qui constitue le diélectrique de ce condensateur est le siège d'un déplacement électrique, chaque section du fil de jonction aura été traversée par une quantité d'électricité égale au déplacement, et les armatures seront chargées, l'une positivement, l'autre négativement, bien qu'elles soient au même potentiel. Si l'on vient alors à rompre la communication entre ces armatures, elles resteront chargées l'une et l'autre ; ce sont ces charges dont je me suis proposé de contrôler l'existence.

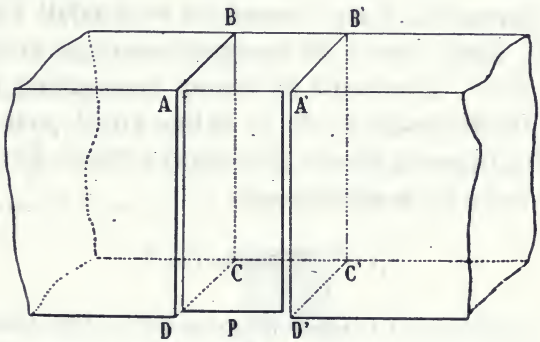

Fig. 1.

Voici comment j'ai disposé l'expérience : Le champ est produit par un électro-aimant du modèle P. Weiss, dont les surfaces polaires en regard (*fig.* 1) sont des rectangles ABCD et A'B'C'D', ayant $2^{cm},8$ de hauteur et 1 centimètre de largeur ; la distance de ces surfaces polaires est $1^{cm},4$. L'une des armatures du condensateur est formée d'une plaque rectangulaire en laiton CBB'C', soudée aux pièces polaires et communiquant avec le sol ; l'autre armature est une plaque rectangulaire P en laiton, plus étroite de $0^{cm},1$ que la première, et disposée de manière à remplir le rectangle ADD'A', sans toutefois toucher les pièces polaires ; cette armature est isolée et maintenue en place à l'aide d'un manche en paraffine, non représenté sur la figure. Les faces polaires de l'électro-aimant et les armatures du condensateur laissent ainsi entre elles un espace vide en forme de parallélipipède rectangle : c'est dans cette sorte de tube vertical que le courant d'air est lancé de bas en haut. Ce courant d'air est produit par la détente d'une masse d'air comprimé à $2^{atm},2$ dans un réservoir de 12 litres ; l'air était préalablement parfaitement desséché, puis filtré à travers une colonne de ouate. Un tube gros et court, muni d'un robinet à large ouverture, sert à amener au-dessous de l'ouverture DCC'D', le courant d'air produit par la détente. Celle-ci s'obtient en ouvrant subitement le robinet, puis le refermant aussitôt ; au moment de l'ouverture maxima du robinet, un ressort métallique, qui jusque-là faisait communiquer l'armature P avec l'autre, est écarté par la clef du robinet et reste écarté.

Connaissant l'aire de l'orifice, qui est $1^{cmq},5$, la chute de pression, qui était d'environ 0,3 atmosphère, et la durée de l'ouverture du robinet, qui était d'environ $0^s,11$, on peut calculer approximativement la vitesse du courant d'air au moment où se produit l'isolement de l'armature P ; cette vitesse fut trouvée comprise entre 14 000 et 15 000 cent. sec^{-1}. L'intensité du champ magnétique était un peu supérieure à 10 000 unités C. G. S. Si l'on prend pour ce champ la valeur 10 000, et pour la vitesse la valeur 14 000, la force électromotrice induite entre les armatures est :

$$1,4 \times 10^8 \text{ unités C.G.S.},$$

c'est-à-dire sensiblement la force électromotrice d'un élément Leclanché. La charge acquise par l'armature P doit donc, d'après Hertz, être la même, au moins, que si l'on chargeait le condensateur à l'aide d'un Leclanché. Pour déceler cette charge, j'ai employé la méthode décrite par moi dans une note récente (1) ; dans cette note, j'ai rapporté que la charge de la plaque P, obtenue, à l'aide d'un Leclanché, dans les conditions ci-dessus, correspond en moyenne à 23 millimètres de la règle. Or, ayant répété l'expérience d'insufflation plusieurs centaines de fois, je n'ai jamais obtenu que des déviations de ± 3 millimètres ou ± 4 millimètres au plus, c'est-à-dire de l'ordre de ce que peuvent produire des causes accidentelles. Voici en particulier les résultats d'une série de quarante expériences que j'ai exécutées, en dernier lieu, avec toutes les précautions que m'avaient suggérées cinq mois de travaux sur ce sujet ; *n* était pris égal à 15,

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(1) Blondlot, *Comptes Rendus*, t. CXXXIII, p. 717 ; 1901 ; et *J. de Phys*, ce vol., p. 5.

et le potentiel du plateau auxiliaire était maintenu par une pile de quatre éléments Leclanché :

1° Dans vingt de ces expériences, le sens de l'aimantation étant tel que P devait, selon Hertz, se charger négativement, j'ai obtenu comme moyenne + 2^{mm},90, tandis que la plaque P, chargée par le Leclanché, donnait en moyenne — 19^{mm},8 ;

2° Le sens de l'aimantation ayant été renversé, j'ai obtenu, pour vingt expériences d'insufflation, une déviation moyenne de — 3^{mm},7, tandis que la charge par le Leclanché donnait + 27^{mm},5 (1).

En résumé, la conclusion invariable de toutes mes expériences est que, dans l'air, le déplacement n'existe pas, ce qui est contraire à la théorie de Hertz sur l'électrodynamique des corps en mouvement, mais conforme à celle de H.-A. Lorentz.

Si j'ai pu mener à bonne fin ces longues et délicates expériences, c'est grâce à l'aide de l'habile et dévoué mécanicien attaché à la Faculté des Sciences de Nancy, M. L. Virtz ; je lui adresse ici mes sincères remerciements.

Le fait que je viens d'établir en entraîne un autre, à savoir qu'une masse d'air qui est le siège d'un déplacement électrique, ne subit aucune action de la part d'un champ magnétique.

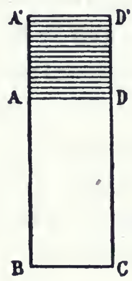

Fig. 2.

Considérons, en effet, l'expérience suivante : Un circuit rectangulaire ouvert ABCD (*fig.* 2) est relié en A et D aux deux armatures AA' et DD' d'un condensateur à air, qui sont toutes deux normales au plan ABCD. Une boîte isolante très mince sert à rendre l'air du condensateur mécaniquement solidaire des armatures. Cet appareil

(1) Le fonctionnement de l'électromètre présentait une certaine dissymétrie relativement aux signes des charges, ce qui tient à ce que l'aiguille est en aluminium, tandis que les plateaux fixes sont en cuivre. Cette dissymétrie n'est, du reste, aucunement gênante.

étant placé dans un champ magnétique uniforme, dont les lignes de force sont normales au plan ABCD, donnons à l'ensemble une translation parallèle à AB. Il y aura courant induit, car il naîtra une force électromotrice d'induction le long de BC, qui coupe normalement les lignes de force tandis qu'il n'y en aura ni le long de AB ni le long de CD, qui ne les coupent pas, ni non plus dans l'air du condensateur, d'après les expériences décrites plus haut. Maintenant il est clair que, en accélérant convenablement le mouvement de translation, on pourra obtenir un courant constant ; on aura alors simplement, pour son intensité :

$$i = \frac{-\frac{dN}{dt} - V}{R},$$

N désignant le nombre de lignes de force coupées par BC à partir d'un instant quelconque, R la résistance du fil, et V la différence de potentiel des armatures du condensateur. On tire de là, en multipliant par idt,

$$-idN = i^2Rdt + Vidt.$$

D'ailleurs, $Vidt$ est le gain d'énergie du condensateur [1], et l'égalité précédente signifie que l'effet Joule, augmenté de l'accroissement de l'énergie du condensateur, forme l'équivalent du travail accompli par l'agent qui, lors de la translation, a surmonté les forces électromagnétiques agissant sur BC ; d'après le principe de la conservation de l'énergie, il ne peut exister d'autre travail extérieur et, par conséquent, il n'y a aucune action électromagnétique du champ sur le courant de déplacement, qui a pour siège l'air du condensateur.

Si l'on applique à cette proposition le principe de l'égalité de l'action et de la réaction, on en conclut qu'un courant de déplacement dans l'air n'exerce aucune action magnétique et que, par conséquent, le courant de charge d'un condensateur est un courant ouvert au point de vue magnétique. C'est la négation même de l'un des principes sur lesquels repose la théorie de Maxwell ; si donc on

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(1) En effet, idt est l'accroissement de la charge du condensateur ; si l'on appelle C sa capacité, on a :

$$idt = CdV; \qquad \text{d'où} \qquad Vidt = CVdV = d\left(\frac{CV^2}{2}\right).$$

veut maintenir cette théorie, il faut renoncer au principe de la réaction.

M. H. Poincaré a déjà signalé cette incompatibilité entre le principe de la réaction et plusieurs des théories de l'Électrodynamique. Pas plus que lui, je ne vois dans ce fait une raison de renoncer d'avance à ces théories dont la fécondité est attestée par les découvertes capitales auxquelles elles ont donné naissance.

PHYSIKALISCHE ZEITSCHRIFT
VOL. 4, P. 229 (1903)

Über die magnetische Wirkung elektrischer Verschiebung.

Von John B. Whitehead jr.

In der Entwickelung seiner Theorie des elektromagnetischen Feldes nimmt Maxwell an, dass die Erscheinung der Polarisation in einem Dielektrikum in einer wirklichen Fortpflanzung oder Verschiebung einer Ladung in der Richtung der Polarisation besteht; dass z. B. für den Fall der Ladung eines Kondensators diese Verschiebung einem Strome gleichwertig ist, der in jedem Augenblicke dem Betrag der Änderung der Oberflächenladung auf einer der Platten gleich ist, d. h.

$$q = \frac{K}{4\pi} \frac{dF}{dt},$$

wo q = der Stromdichte, K = der Dielektrizitätskonstante und F = der Potentialdifferenz pro Längeneinheit ist und dass daher der Strom durch den ganzen Schliessungskreis hindurch kontinuierlich ist. Er nimmt weiter an, dass der Verschiebungsstrom die gleiche magnetische Wirkung hervorbringt wie ein Leitungsstrom der Dichte

$$q = \frac{K dF}{4\pi\, dt},$$

so dass für den Fall des Kondensators die magnetische Wirkung in der Umgebung, die bei jeder Ladungsänderung eintritt, der vereinigten Wirkung des Stromes in den ladenden Drähten und dem Verschiebungsstrom im Dielektrikum zu verdanken sei.[1])

Die direkte magnetische Wirkung der Verschiebungsströme ist jedoch nie in befriedigender Weise, wenn überhaupt, beobachtet worden; die veröffentlichten Versuche in dieser Richtung scheinen sich zu beschränken auf Röntgen[2]), S. P. Thompson[3]), Nicolaiff[4]) und Blondlot.[5]) Die Resultate der drei ersten Forscher liessen keine Schlussfolgerungen zu und Blondlots Versuche deuteten auf die Abwesenheit einer Wirkung.

Die im folgenden beschriebenen Versuche wurden unternommen, teils weil die bisherigen Versuche eine Ungewissheit hinsichtlich des Bestehens der Wirkung fortbestehen liessen, teils weil die angewandte Methode Vorteile über die bisher benutzte zu bieten schien. Das Prinzip der Methode ist, ein Stück eines Dielektrikums einem elektrischen Wechselfelde und einem magnetischen Wechselfelde auszusetzen, die Phasen der beiden Wechselfelder, deren Richtungen im Raume rechtwinklig aufeinander stehen, so zu justieren, dass die Reaktion des Verschiebungsstromes gegen das Magnetfeld ein Maximum wird und zu beobachten, ob eine Bewegung des Dielektrikums in einer Richtung, die senkrecht zu der Ebene erfolgt, welche das wirksame elektrische und magnetische Feld umfasst, eintritt.

1) Maxwell, Electricity and Magnetism. Art. 60, 75, 76, 111, 328—334, 608, 783, 791.
2) Rep. der Physik, 21, 521, 1885.
3) Proc. Roy. Soc. XLV, 392, 1889.
4) Journ. Phys 4, 245, 1895.
5) Journ. Phys., Jan. 1902.

In jeder der vier Formen des dieses Prinz verkörpernden Apparates war ein Stück d Dielektrikums starr an jedem Ende einer leic ten Achse befestigt, die durch einen im Mitt punkt befestigten Quarzfaden horizontal a gehängt war. Die Phase des elektrischen od des magnetischen Feldes, das an dem ein Stück wirkte, war um 180° gegen das a andern Stück wirkende verschoben, währe das andere Feld für beide Stücke gleiche Pha hatte. Dadurch hat die Gegenwirkung d Verschiebungsstromes gegen das magnetisc Feld entgegengesetzte Richtung an beid Enden der Achse, so dass ein Kräftepaar a die Aufhängung wirkt.

Der Apparat.

Erste Form: Fig. 1 giebt einen Querschni *AA* sind die rechteckigen Blöcke des Diele trikums, die an der Achse *D*, die aus Bamb oder Glas gefertigt war, befestigt waren. *BBE* sind Messingelektroden, von denen eine je so gedreht war, dass ihre Oberfläche ein Teil eines Kreiscylinders bildete, dessen Ach mit der Aufhängungs-Richtung und -Linie d Bambus- oder Glasstabes zusammenfiel; a diese Weise schien sich die beste Annäheru an ein gleichförmiges Feld zwischen den Ele troden erreichen zu lassen. Jedes Elektrode paar war mit den Enden eines Transformato verbunden, der 8800 Volts bei 133 Wechse pro Sek. gab. *CC* sind kreisförmige Drah spulen, von denen je eine ein Elektrodenpa umgiebt; die Ebenen der Windungen si horizontal. Die Spulen erhalten ihren Wechse strom von demselben Generator wie die Ele troden.

Wie man sieht, ist das Magnetfeld vertik das elektrische Feld horizontal, so dass d resultierende Ablenkung des Stabes auf d einen Seite aus der Ebene der Zeichnung hera auf der anderen Seite in die Ebene der Zeic nung hinein erfolgen sollte. Das Ganze sta auf einer hölzernen Basis und jede Hälfte d Apparates war in eine Messinghülle eingeba Die Verbindung zwischen den beiden Hälft war so eng, dass der Stab noch schwing konnte. Auf diese Weise war das Innere s klein wie möglich gemacht und Störungen dur Luftströmungen auf ein Minimum reduzie Ein eng anliegender Messingcylinder innerha der Spule, ein Ring an deren oberen u Zinnfolie an deren unteren Ende, all das m dem Gehäuse verbunden, beschützte das D elektrikum vor irgend welchem von der Spu ausgehenden elektrischen Felde; alle möglich sekundären Stromkreise wurden gespalten u die Öffnungen mit Hartgummi oder Faser g schlossen.

Die in der Figur zu sehende Dämpfungs-
›rrichtung war ein im Wasser tauchendes limmerblättchen, das durch ein dünnes Glasäbchen am abzulenkenden Stabe befestigt war. er angewandte Quarzfaden war immer unefähr 102 cm lang; er befand sich in einem lasrohr, das mit einem Torsionskopf versehen ar, der unabhängig Justierungen der Torsion ıd der Länge gestattete; an seinem unteren nde trug der Quarzfaden einen kleinen Kupferıken, der in einen entsprechenden auf den lasstab gekitteten Haken passte. In der Mitte es Stabes war ein Spiegel, der das Bild eines lühlampenfadens auf eine auf Glas geätzte kala warf; später wurde die Glühlampe durch nen Nernstschen Glühkörper ersetzt, der

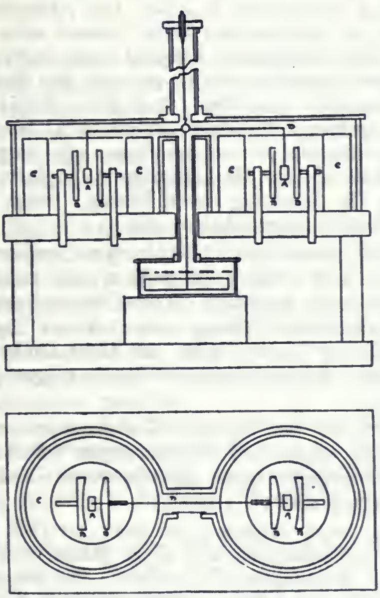


Fig. 1.

ich hierzu vorzüglich eignet. Der Abstand Spiegel-Skala war 140 cm. Die Schaltung zeigt Fig. 2. Die beiden Magnetisierungsspulen vurden so geschaltet, dass ihre Felder immer leich stark, gleich gerichtet und parallel waren, während die Elektroden so geschaltet waren, lass ihre Felder gleich stark und parallel waren, ıber in entgegengesetzten Richtungen arbeiteten.

Berechnung der erwarteten Wirkung:

Der Abstand der Elektroden war bei jedem Paar gleich 1,9 cm; die Dielektrika waren Stücke von Steinsalz, Glas oder Paraffin. 1 cm × 1 cm × 0,63 cm und mit ihren quadratischen Seiten parallel zu den Elektroden aufgehängt, so dass ein Drittel einer Kraftlinienlänge innerhalb des Dielektrikums war. Da nun $\sqrt{2 \cdot 8800}$

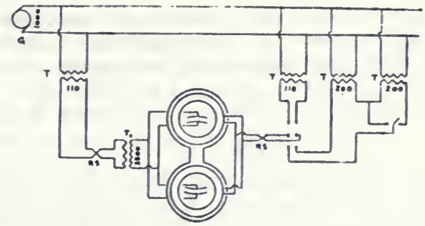


Fig. 2.

die maximale E.M.K. zwischen den Elektroden war, so ist der auf das Dielektrikum wirksame Teil gegeben durch

$$V = \frac{\sqrt{2 \cdot 8800}}{2K + 1}.$$

Die Intensität der E.M.K. $F_m = \frac{dV}{dl}$, also

$$F_m = \frac{\sqrt{2 \cdot 8800}}{(2K + 1) \cdot 0{,}63} \text{ (Maxim.-Wert in Volts).}$$

Die Dichte des Verschiebungsstromes = $q = \frac{K}{4\pi}\frac{dt}{dF}$; da nun die E.M.K. alternierend ist, so haben wir

$$F = F_m \sin a$$

und

$$q = \frac{K}{4\pi} F_m \cos a \frac{da}{dt}.$$

$\frac{da}{dt}$ = der Winkelgeschwindigkeit $= 2\pi N = \pi \cdot 133$

also

$$q = \frac{K}{4\pi} \cdot \frac{\sqrt{2 \cdot 8800}}{(2K + 1) \cdot 0{,}63} \cdot \frac{2\pi \cdot 133 \cdot 10^8}{3 \cdot 10^{10}} \cos a \text{ in}$$

C. G. S. elektrost.

$$q = \frac{K}{4\pi} \cdot \frac{\sqrt{2 \cdot 8800}}{(2K + 1) \cdot 0.63} \cdot \frac{2\pi \cdot 133 \cdot 10^8}{(3 \cdot 10^{10})^2 \cdot 10^{-1}} \cos a$$

Ampères

$$= \frac{K}{2K + 1} \cdot \frac{14{,}6}{10^7} \cos a$$

$$= \frac{K}{2K + 1} \cdot \frac{10 \cdot 3}{10^7}$$ eff. Ampères pro Querschnitteinheit.

Jede der Spulen für das Magnetfeld enthielt 1200 Windungen von B. & S. Nr. 18 Magnetdraht. Das mit Vernachlässigung der Wirkung der Enden berechnete Magnetfeld für die Mitte der Spulen war 200 i (i = Stromstärke in Ampères); es ergab durch die Messung mit einer Spule von bekannter Oberfläche und Windungszahl zu 166 i. (Diese Spule hatte eine Oberfläche von 25 cm^2 und 400 Windungen. Der induzierte Strom 2,4 Amp. bei 33,5 Volts und 133 Wechseln.) Der Widerstand jeder Spule war ungefähr = 9 Ω, und die berechnete Selbstinduktion L = 0,109 Henry; bei 144 Volts, 133 Wechseln nahm eine jede

1,3 Amp., was eine Selbstinduktion von 0,104 L ergiebt. Ist Θ die Phasendifferenz zwischen der E.M.F. und dem Strom, so ergiebt sich

$$tg\Theta = \frac{2\pi NL}{R} \quad \frac{6,28 \cdot 133 \cdot 0,104}{9} \quad 9,3, \text{ d. h.}$$

$$\Theta = 83^0\ 52'.$$

Da die Phasendifferenz zwischen den primären und sekundären E.M.K. eines Transformators ungefähr 180⁰, ist, die an den Elektroden wirkende Kraft aber zweier Transformationen unterzogen war, so ist sie demnach gleichphasig mit der Generator = E.M.K. Sei ihre Phase bezeichnet mit *sin* α. Der resultierende Verschiebungsstrom hat, wie oben gezeichnet, die Phase *cos* α, d. h er ist um 90^0 gegen die Generator E.M.K. verschoben. Die auf die Spulen wirkende E.M K. ist nur einmal umgewandelt worden, also ist sie um 180^0 verzögert; wegen der Selbstinduktion der Spule eilt der Strom und deshalb auch das entst. Magnetfeld um 90^0 nach. Demzufolge sind der Verschiebungsstrom und das Magnetfeld um 180^0 auseinander, liegen also günstig zur Erzeugung der elektromagnetischen Gegenwirkung. Da nun für die Spule $\Theta = 83^0\ 52'$ gefunden wurde, so muss die für Koinzidenz berechnete Wirkung mit $0,9942 = cos\ 6^0\ 8'$ multipliziert werden.

Auf den Strom im Dielektrikum wirkt also eine Kraft

$$0,994 \frac{lgH}{10} = 0,63 \cdot \frac{K}{2K+1} \cdot \frac{10 \cdot 3}{10^7} \cdot \frac{166 \cdot 1,2}{10}.$$

$$0,9942 = \frac{K}{2K+1} \cdot \frac{22,8}{10^6} \text{ Dynen,}$$

wenn in jeder Spule 1,2 Ampères fliessen, l die Dicke des Dielektrikums oder die Länge des Verschiebungsstromes ist, und H = der Intensität des Magnetfeldes. Diese Kraft wirkt in entgegengesetzter Richtung an beiden Enden der aufgehängten Achse von 17,78 cm Länge. Es wirkt also ein Paar von

$$\frac{K}{2K+1} \cdot \frac{2,28}{10^4} \text{ Dynen-Centimeter.}$$

Der Drehungswinkel eines Fadens der Länge l, vom Radius r und vom Starrheitskoeffizienten n, auf den ein Kräftepaar u wirkt, ist

$$\Phi = \frac{2lu}{\pi r^4} \cdot \frac{1}{n}.$$

Die Länge des Quarzfadens war 101,6 cm; der Radius war sehr annähernd = 0,0006 cm. Nimmt man n für Quarz zu $3 \cdot 10^{11}$, so ist

$$\Phi = \frac{K}{2K+1} \cdot \frac{2 \cdot 101,6 \cdot 2,28}{\pi \cdot 0,0006^4 \cdot 10^4 \cdot 3 \cdot 10^{11}} = \frac{K}{2K+1} \cdot 37 \text{ radians.}$$

Ist K für Steinsalz = 5,8, so ist $\Phi = 0,173$, was bei einem Spiegelabstand von 140 cm einer Ablenkung von $2 \cdot 1400 \cdot 0,173 = 485$ mm oder mehr entspricht, da wir die Tangent[e] dem Bogen gleichgesetzt haben.

Eine Kontrolle schien in einer Umkehrun[g] des Ablenkungssinnes zu liegen, indem ma[n] die Phase des elektrischen oder des magne[-]tischen Feldes um 180⁰ änderte.

Es wurde so vorgegangen, dass man zu[-]nächst die Achse unter dem Einfluss des elek[-]trischen Feldes allein zur Ruhe kommen liess[;] die hierzu nötige lange Zeit war ein weitere[r] Hinweis auf die gute Homogenität des Felde[s]. Dann wurde das Magnetfeld erregt und di[e] entstehende Ablenkung notiert. Hierauf wurd[e] der Sinn entweder des elektrischen oder de[s] magnetischen Feldes umgekehrt und die Ab[-]lenkung beobachtet u. s. w. Die Ablenkunge[n] waren im allgemeinen klein, immer sehr lang[-]sam und brauchten viel Zeit, um sich zu be[-]ruhigen; meistens wurde nur auf den Sinn de[r] Ablenkungen geachtet. Auf diese Weise wur[-]den mehrere hundert Ablesungen gemacht. Diese hatten im allgemeinen ein negative[s] Resultat, d. h. die Ablenkung änderte sic[h] weder in Richtung noch Betrag, wenn eine[s] der Felder umgekehrt wurde.

Nie waren die Ablenkungen grösser al[s] 10 mm und selten grösser als 2 mm; manchma[l] jedoch lagen innerhalb dieses Gebiets Anzeiche[n] der gesuchten Wirkung vor; d. h. der Sinn de[r] Ablenkung änderte sich mit einer Umkehrun[g] entweder des elektrischen oder des magnetische[n] Feldes.

Einmal, mit Glas als Dielektrikum, erhiel[t] man die erwarteten Umkehrungen für 6 Kom[-]mutatorumkehrungen; jedoch waren diese Ab[-]lenkungen nur 2—3 mm.

Es muss indessen bemerkt werden, das[s] diese Ablenkungen aus einer Masse von Ver[-]suchen herausgegriffen wurden, die manchma[l] gar keine, manchmal Ablenkungen in falschen Sinne ergaben. Da das Magnetfeld nahe a[n] den Spulen stärker als in der Mitte ist, so is[t] es möglich, dass die Ablenkungen magnetische[n] Eigenschaften der Dielektrika zuzuschreibe[n] waren, obwohl Versuche dieselben frei vo[n] solchen ergaben.

Die zweite und dritte Form des Apparate[s] wurden konstruiert in der Absicht, ein gleich[-]förmiges Magnetfeld zu erhalten und die ge[-]suchte Wirkung zu verstärken. In beiden Fällen erhielt man keine entscheidenden Re[-]sultate. Da die Form der Elektroden in de[n] oben beschriebenen Versuchen den Dielektrika eine Lage stabilen Gleichgewichts gab, wurd[e] gedacht, dass die Bedingungen zum Gelinge[n] dann am besten sind, wenn sowohl das elek[-]trische wie das Magnetfeld für alle Lagen de[r] Achse gleichförmig und konstant sind. Des gen wurde folgende endgültige Apparatform nstruiert.

Für das Magnetfeld wurde eine breite Spule n 7,62 cm Höhe, 26,6 cm innerer Weite und o Windungen von B. & S.-Draht Nr. 15 be- tzt (siehe Figur 3).

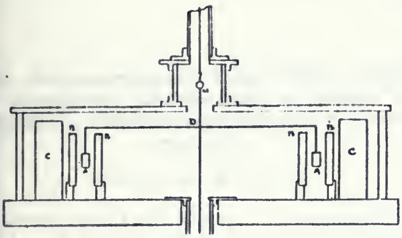


Fig. 3.

Als Elektroden dienten zwei ganze Messing- ıge, die miteinander und der Spule konzen- sch standen. Ihre Oberflächen waren sorg- tig gedreht und poliert und jeder Ring war einer Stelle gespalten, um zu verhindern, ss er ein kurz geschlossener Sekundärkreis erde.

Die Spule war mit geerdeter Zinnfolie sorg- ltig abgeschirmt. Der Aufhängehaken auf r Achse war verlängert, so dass er in einer asröhre bis *M* reichte, und hier der Spiegel efestigt. Indem man die Lichtquelle und die cala in einem Kreis rings um den Apparat ehte, konnte man in jeder Lage der Achse obachtungen machen.

Messungen der Stärke des Magnetfeldes, r Selbstinduktion der Spule u. s. w. zeigten, ss die Grössenordnung der berechneten Ab- ıkung in diesem Apparat die gleiche wie im sten war.

Es zeigte sich, dass die Nulllagen der Achse r die beiden Felder, wenn nur eines anlag, cht die gleichen waren. Eine direkte elek- ische Wirkung der Spule oder der Zuführungs- ähte schien die Ursache davon sein zu müssen, owohl der Zinnfolienschirm so vollkommen wie öglich zu sein schien. Es wurde nun versucht, ne der Lagen, in denen die Achse vom Magnet- ld allein nicht beeinflusst zu werden schien, it einer Nulllage für das elektrische Feld lein zur Koinzidenz zu bringen, indem man e Spule *a* in verschiedene Lagen durch rehung um ihren Mittelpunkt brachte.

Dies gelang nur einmal, und da erhielt man ıch die richtige Umkehrung der Ablenkung. ie Grösse der Ablenkung war 1,5 cm. Einige ındert Ablesungen wurden gemacht, indem erschiedenheiten der Ablenkung für die beiden ıasen jedes Feldes mit Bezug auf das elek- ische gesucht wurden.

Also wurde die Phase des magnetischen Feldes mit Bezug auf das elektrische um 90° gedreht und eine Reihe von Beobachtungen gemacht. Dies geschah, um eine mögliche Nacheilung des Verschiebungsstromes zu finden, die durch molekulare Reibung oder aus andern Gründen entstehen konnte. Alle diese Versuche ergaben negatives Resultat, d. h. die Ablenkungen waren geringer als 2 mm und zeigten keine regelmässige Umkehrung, wenn eines der Felder umgekehrt wurde.

Diese Untersuchung zeigt im grossen Ganzen, dass ein magnetischer Effekt der elektrischen Verschiebung in einem Betrage, wie ihn Max- wells Ausdruck giebt, nicht vorhanden ist. Das einzige positive Resultat, das mit der letzten Form des Apparates erreicht wurde, muss in Frage gestellt werden, denn obwohl die günstigen Bedingungen, unter denen es erhalten wurde, nicht ein zweites Mal erreicht wurden, so wurde sich ihnen doch manchmal in genügender Weise genähert, um Spuren einer Wirkung der beobachteten Grösse geben zu sollen. Die letzte Form des Aufbaues war zweifellos die geeignetste; es erscheinen darin nur zwei Einflüsse, die die gesuchte Wirkung verhindern könnten. Der erste ist eine Änderung des elektrischen Feldes von Punkt zu Punkt und die Neigung des Dielektrikums, im Gebiet grösster Intensität zu verbleiben; der zweite ist die Anwesenheit der Dämpfungsvorrichtung. Jedoch ist anzunehmen, dass keine der beiden gross genug ist, um ein Kräftepaar vom Werte des gesuchten zu verbergen; wie gesagt, waren die Ringe sorgfältig gedreht und justiert, so dass deren Oberflächen in allen Punkten gleichweit voneinander entfernt waren. Andeutungen, als ob sich die Achse eine Lage im elektrischen Felde wählen wollte, waren sehr gering. die Gleichgewichtslagen wurden sehr leicht verlassen, und änderten sich zwischen zwei Ablesungen oft um 1—2 cm. Die Verteilung des von der Spule herrührenden elektrischen Feldes konnte, obwohl ungewiss, keine zu sehr unsymmetrische um das Centrum herum sein, und da die hierdurch veranlasste Störung selten grösser als 1 cm war, so scheint es nicht möglich, dass die Intensitätsänderuugen* gross genug waren, um die Abwesenheit einer sichtbaren Wirkung bei Umkehrung des wirksamen Paares zu veranlassen.

Bei den ersten Versuchen wurden einige Beobachtungsreihen ohne die Dämpfung gemacht; die einzige Verschiedenheit war, dass die Achse längere Zeit brauchte, um zur Ruhe zu gelangen.

Mit der letzten Apparatform konnten ohne die Dämpfung keine Beobachtungen gemacht werden. das elektrische Feld war so annähernd gleichförmig, dass die Achse keine so statio-

*Intensitätsänderungen

näre Lage einnehmen wollte, die als Nullpunkt hätte benutzt werden können.

Phys. Institut d. Johns Hopkins Universität.
Mai 1902.

(Aus dem Englischen übers. von S. Guggenheimer.)

(Eingegangen 15. Oktober 1902.)

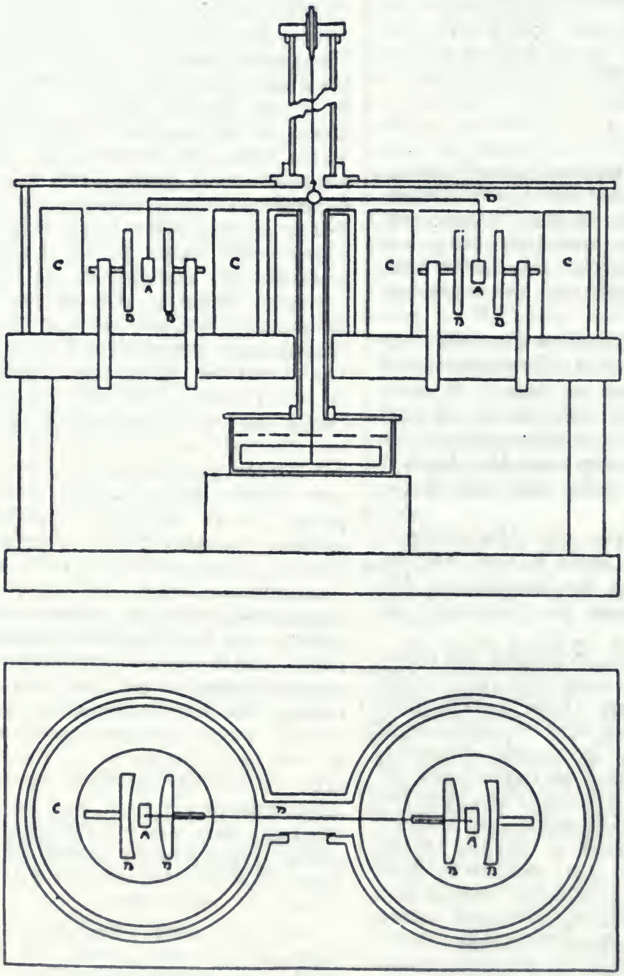


Fig. 1.

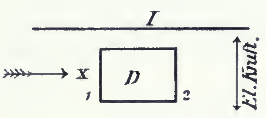
(Fig. 1 of Whitehead's paper is given here enlarged)

Jber die ponderomotorischen Kräfte, welchen in homogenes Dielektrikum in einem ver-nderlichen elektromagnetischen Felde unter-worfen ist.

Von Franz Koláček.

Unter dem Titel „Über die magnetische Virkung elektrischer Verschiebung" von ohn B. Whitehead jr., erschien in dieser Leitschrift (4, 229, 1903) eine Abhandlung, in velcher sorgfältige Versuche beschrieben werden, leren Resultate für die Maxwellsche Lehre om elektromagnetischen Felde verhängnisvoll verden könnten, wenn sie sich nicht anders nterpretieren liessen als durch Nichtwirkung les Magnetfeldes auf Verschiebungsströme.

Im wesentlichen handelt es sich um die experimentelle Untersuchung des Antriebes, velchen ein rechteckiger Block D eines Dielek-rikums (siehe Figur) im periodisch veränder-



ichen elektrischen Felde eines Kondensators , I erfährt, wenn senkrecht zu den elektrischen Kraftlinien und zur (möglichen) Bewegungs-ichtung des Blockes x ein gleichfrequentes, veränderliches magnetisches Feld erregt wird. Der beste Erfolg ist offenbar dann zu erwarten, venn der Maxwellsche Verschiebungsstrom ınd der das Magnetfeld erregende Spulenstrom n gleicher Phase sind. Im Whiteheadschen Arrangement liess sich unter der Voraussetzung, lass die Verschiebungsströme allein die Ur-sache des Antriebes sind. die Stärke desselben berechnen. Dieselbe hätte eine Drehung des nit D verbundenen Hebels im Betrage von 185 Skalenteilen ergeben müssen, während that-sächlich das Beobachtungsresultat negativ war.

1. Dies ist, wie im folgenden gezeigt wer-len soll, in bester Übereinstimmung mit den Maxwell-Faradayschen Anschauungen, denen zufolge die Fernwirkung polarer Massen auf Spannungen zurückzuführen ist. Ihr Betrag ässt sich an der Hand des Energieprinzips berechnen (Helmholtz-Kirchhoff). Ist K die Dielektrizitätskonstante, X, Y, Z, ϱ die elektro-statisch gemessene elektrische Kraft, resp. Dichte, so gilt für die Komponenten der Spann-ungen elektrischer Art die Gleichungenreihe

$$\left.\begin{aligned} X_x &= \frac{K}{8\pi}(X^2 - Y^2 - Z^2), \quad X_y = \frac{KXY}{4\pi}, \\ X_z &= \frac{KXZ}{4\pi} \text{ etc.} \end{aligned}\right\} \quad (0)$$

Die Spannungskomponenten X_x, X_y, X_z an einer Raumst(e)lle erscheinen hier ausgedrückt durch die daselbst bestehenden Kräfte, und müssen, da es nur auf die Existenz dieser Kräfte und nicht auf deren Ursprung ankommt, auch dann richtig bleiben, wenn die Kräfte kein Potential besitzen. Eine Konsequenz dieser Idee ist beispielsweise das Gesetz der pondero-motorischen Wirkung eines Magnetfeldes auf ein Stromelement (siehe weiter unten).

Die ponderomotorische Kraft elektrischen Ursprungs Ξ_e, H_e, Z_e beträgt per Volumeinheit

$$\left.\begin{aligned} \Xi_e &= \frac{\partial X_x}{\partial x} + \frac{\partial X_y}{\partial y} + \frac{\partial X_z}{\partial z} = KY\gamma - \\ &\qquad KZ\beta - \frac{\partial K}{\partial x} \cdot \frac{H^2}{8\pi} + X\varrho \\ H_e &= KZ\alpha - KX\gamma - \frac{\partial K}{\partial y}\,\frac{H^2}{8\pi} + Y\varrho \\ Z_e &= KX\beta - KY\alpha - \frac{\partial K}{\partial z} \cdot \frac{H^2}{8\pi} + Z\varrho, \end{aligned}\right\} \quad (1)$$

wobei

$$\left.\begin{aligned} & H^2 = X^2 + Y^2 + Z^2; \; 4\pi\alpha = \frac{\partial Y}{\partial z} - \frac{\partial Z}{\partial y}, \; 4\pi\beta = \\ & \frac{\partial Z}{\partial x} - \frac{\partial X}{\partial z}, \quad 4\pi\gamma = \frac{\partial X}{\partial y} - \frac{\partial Y}{\partial x}, \quad 4\pi\varrho = \frac{\partial}{\partial x} \\ & (KX) + \frac{\partial}{\partial y}(KY) + \frac{\partial}{\partial z}(KZ) \text{ gesetzt ist.} \end{aligned}\right\} \quad (2)$$

Von der Richtigkeit der Formeln (1) kann man sich an der Hand der Gleichung (0) und (2) durch Derivationen unmittelbar überzeugen.

Eine ähnliche Gleichungenreihe gilt für die Spannungen magnetischer Art. Schliessen wir magnetische Raumdichten (ϱ) überhaupt aus und beschränken uns auf Medien von überall gleicher Permeabilität $K = 1$, so erhalten wir, falls L, M, N Komponenten der magnetischen Kraft bedeuten, für die ponderomotorischen Volumkräfte magnetischer Art die Gleichungen:

$$\left.\begin{aligned} \Xi_m &= M\gamma' - N\beta'. \quad H_m = N\alpha' - L\gamma', \\ Z_m &= L\beta' - M\alpha' \end{aligned}\right\} \quad (3)$$

$$\left.\begin{aligned} 4\pi\alpha' &= \frac{\partial M}{\partial z} - \frac{\partial N}{\partial y}, \quad 4\pi\beta' = \frac{\partial N}{\partial x} - \frac{\partial L}{\partial z}, \\ 4\pi\gamma' &= \frac{\partial L}{\partial y} - \frac{\partial M}{\partial x} \end{aligned}\right\} \quad (4)$$

Die Grössen α', β', γ' sind offenbar identisch mit den an einer Raumstelle x. y, z eventuell bestehenden Komponenten der Stromdichte h der Richtung λ, μ, ν; also $\alpha' = h\lambda$, $\beta' = h\mu$, $\gamma' = h\nu$. Sei ferner dl das Element eines Stromfadens, q sein Querschnitt, $i = hq$ die Stromintensität.

Die Kraft auf das Element eines Stromfadens vom Volumen $d\,l\cdot q$ ist dann gegeben durch:

$$A_x = (Mv - N\mu)\cdot dl\cdot i,\quad A_y = (N\lambda - Lv)\cdot dl\cdot i,$$
$$A_z = (L\mu - M\lambda)\cdot dl\cdot i.$$

Man ersieht aus dieser Formel, dass der Antrieb auf der Feld- und Stromrichtung senkrecht steht und durch $dl.\ i.\ \sin\sigma$ gegeben ist, wobei σ den Winkel zwischen Strom- und Feldrichtung angiebt. Aus der weiteren Übereinstimmung der Kraftrichtung mit jener, die man durch die bekannte Zeichenregel ausdrückt, schliessen wir, dass die Gültigkeitserweiterung der Spannungsformeln auf Kräfte ohne Potential berechtigt war.

2. Kehren wir nun zur eigentlichen Aufgabe zurück. Das Dielektrikum (D) 1 erfährt innerhalb eines Dielektrikums 2 in der Richtung der x-Achse einen resultierenden Zug A, der sich auf Spannungen beider Kräftearten zurückführen lässt. Derselbe kann sich nur um unendliche kleine Grössen von jenem Zuge unterscheiden, den eine den Körper D eng umschliessende Fläche A_2 seitens des Mediums 2 erfährt. Denken wir uns den diskontinuierlichen Übergang des Mediums 1 in 2 durch einen unendlich rasch veränderlichen, aber stetigen Übergang ersetzt, bezeichnen ferner mit $d\tau$ ein Element des von A_2 umschlossenen Raumes, so ist dem Greenschen Satze zufolge

$$A = \int d\tau\,(\Xi_e + \Xi_m) = -\int \frac{d\tau}{8\pi}\frac{\partial K}{\partial x}\cdot H^2 +$$
$$\int d\tau\,\{KY\gamma - KZ\cdot\beta + M\gamma' - Z\beta'\} + \int d\tau\, X\cdot\varrho.$$

Das zweite Integral rechts transformieren wir an der Hand der Maxwellschen Grundgleichungen:

$$4\pi w + \frac{K}{V}\cdot\frac{\partial Z}{\partial t} = \frac{\partial L}{\partial y} - \frac{\partial M}{\partial x} = 4\pi\gamma';$$
$$\frac{\partial N}{\partial t}\cdot\frac{1}{V} = \frac{\partial X}{\partial y} - \frac{\partial Y}{\partial x} = 4\pi\gamma$$
$$4\pi u + \frac{K}{V}\cdot\frac{\partial X}{\partial t} = \frac{\partial M}{\partial z} - \frac{\partial N}{\partial y} = 4\pi\alpha';$$
$$\frac{\partial L}{\partial t}\cdot\frac{1}{V} = \frac{\partial Y}{\partial z} - \frac{\partial Z}{\partial y} = 4\pi\alpha$$
$$4\pi v + \frac{K}{V}\cdot\frac{\partial Y}{\partial t} = \frac{\partial N}{\partial x} - \frac{\partial L}{\partial z} = 4\pi\beta';$$
$$\frac{\partial M}{\partial t}\cdot\frac{1}{V} = \frac{\partial Z}{\partial x} - \frac{\partial X}{\partial z} = 4\pi\beta,$$

in welchen X, Y, Z die Kräfte auf eine elektrostatische Einheit, u, v, w die elektromagnetisch gemessenen Dichten der Ohmschen Ströme und V die Webersche Zahl bedeuten, in

$$A = A_1 + A_2 + \int d\tau\,\varrho X \quad . \quad . \quad . \quad (4a)$$

wobei gesetzt ist

$$\left.\begin{aligned} A_1 = -\frac{1}{8\pi}\int d\tau \frac{\partial K}{\partial x}\cdot H^2,\quad A_2 = \int d\tau\,(Mw \\ - Nv) + \frac{K}{4\pi V}\frac{\partial}{\partial t}\int d\tau\,(ZM - YN)\end{aligned}\right\}\cdot(5)$$

Die Integration erstreckt sich bis zur Fläche A_2. Die Grösse $\partial K/\partial x$ ist im homogenen Medium 1 Null bis hart an die Grenze, ändert sich aber von da ab in der Richtung der Normalen n, die wir von 1 zu 2 positiv zählen, unendlich rasch. Sind s und t zwei zu einander und zu n senkrechte Richtungen, so gilt

$$\frac{\partial K}{\partial x} = \frac{\partial K}{\partial s}\cos(s, x) + \frac{\partial K}{\partial t}\cos(t, x) +$$
$$\frac{\partial K}{\partial n}\cos(n, x).$$

Da nun $\partial K/\partial s$ und $\partial K\,\partial t$ endlich und $\partial K/\partial n$ unendlich gross ist, so hat man in limite

$$\frac{\partial K}{\partial x} = \frac{\partial K}{\partial n}\cos(n, x).$$

Die Volumintegration in A_1 erstreckt sich offenbar von einer inneren Grenzfläche A_1, an welcher K noch den Wert K_1 hat, bis zur äusseren Fläche A_2, wo derselbe K_2 ist.

Ist ferner N die Normalkomponente und T die Tangentialkomponente der elektrischen Kraft inmitten des veränderlichen Gebietes an einer zu A_1 und A_2 parallelen Zwischenfläche, so ist daselbst

$$H^2 = T^2 + N^2 = T^2 + \frac{(KN)^2}{K^2}.$$

Dabei sind T und KN (die Normalkomponente der elektrischen Induktion) bei Abwesenheit von absoluten Ladungen von n unabhängige Grössen, für welche die Werte T_2 und K_2N_2 an der äusseren Fläche A_2 gesetzt werden dürfen.

Man hat also, wenn mit $d\omega$ ein Flächenelement bezeichnet wird, wegen $d\tau = d\omega\cdot dn$

$$A_1 = -\frac{1}{8\pi}\int d\omega\cos nx\int_{A_1}^{A_2} dn\frac{\partial K}{\partial n}$$
$$\left(T_2^2 + \frac{K_2^2N_2^2}{K^2}\right)$$

oder

$$A_1 = \frac{K_1 - K_2}{8\pi}\int d\omega\cos nx\left(T_2^2 + \frac{K_2^2N_2^2}{K_1}\right) \quad (6)$$

Wenden wir die Formeln (4a), (5) und (6) auf den Whiteheadschen Versuch an.

Der erste Teil von A_2 ist Null, weil Ohmsche Ströme im Dielektrikum überhaupt nicht existieren, aber auch der auf eine Periode bezogene Mittelwert von A_2, der im Versuche allein massgebend ist, ist Null. Ferner ist laut (6) A_1 gleich Null, weil in zwei gegenüber liegenden Punkten 1, 2 von D (siehe Figur) T_2^2

d N_2^2 gleiche, aber $\cos n x$ entgegengesetzte erte besitzen. An den zwei anderen Flächen $\cos n x = 0$. Weil nun auch $\varrho = 0$ ist, so ist r Antrieb A in der x-Richtung Null und das esultat des Versuches im Einklang mit der axwellschen Theorie. (Selbstverständlich ürde das nämliche Resultat gelten, wenn D e Form eines zu I I symmetrischen gelegenen ıd symmetrischen Körpers besässe.)

Aus (4a) und (5) ergiebt sich, dass auch olumteile des ruhenden Äthers einen Antrieb

$$\frac{K}{4\pi V}\frac{\partial}{\partial t}(ZM - YN),\quad \frac{K}{4\pi V}\frac{\partial}{\partial t}(XN - ZL),$$

$$\frac{K}{4\pi V}\frac{\partial}{\partial t}(YL - XM)$$

er Volumeinheit erfahren, wenn derselbe von ektromagnetischen Wellen durchsetzt wird, ie dies zuerst von Hertz ausgesprochen und n Helmholtz näher ausgeführt wurde. (Wied. nn. **53**, 135, 1894).

3. Wir bemerken noch, dass laut (4a), (5) er Antrieb auf das Volumelement eines hoıogenen Körpers sich aus drei Teilen zusamıensetzt. Der erste entspricht der Wirkung es elektrischen Feldes auf die in ihm eventuell orhandene Ladung, der zweite jener des Magetfeldes auf den aus Leitungs- und Verchiebungsstrom zusammengesetzten totalen trom, der dritte wiederum der Wirkung des ektrischen Feldes auf eine Art magnetischen erschiebungsstrom. Man sieht dies unmittelar ein, wenn man die in (5) angedeutete Devation nach t ausführt.

Der Betrag dieses dritten Teiles zum Anriebe ist per Volumeneinheit

$$\frac{K}{4\pi V}\left(Z\frac{\partial M}{\partial t} - Y\frac{\partial N}{\partial t}\right) \text{ etc.}$$

4. Die Lorentzsche Theorie hält den Leitngsstrom für einen Fortführungsstrom geladener lektrischer Massen, vindiziert aber auch den Iaxwellschen Verschiebungsströmen magetische Kraftwirkungen. Dagegen soll ein olumteil ponderomotorischen Kräften nur inofern unterliegen, als er Träger von Ladungen nd Fortführungsströmen ist; auf den Verchiebungsstrom wirkt also ein Magnet nicht. ıfolge dieser Annahmen ist sie nun allerings in Übereinstimmung mit dem Whiteeadschen Versuch, da ja das Dielektrikum) keinerlei Ladung besitzt.

Anders wäre es, wenn das elektrische Feld onstant bliebe und die Richtung des magetischen (konstanten) Feldes umgekehrt würde. Der Maxwellschen Theorie zufolge wäre in ballistischer Ausschlag zu erwarten, da in er Richtung x eine impulsive Kraft wirkım ist.

Nach Lorentz sollte kein Ausschlag erfolgen.

Versuche in dieser Richtung wären von grossem Werte.

(Eingegangen am 22. November 1903.)

Magnetische Wirkung elektrischer Verschiebung.

Von J. B. Whitehead.

In einer früheren Arbeit (diese Zeitschrift **4**, 229, 1903) hat der Verfasser eine Reihe von Versuchen beschrieben, deren Zweck es war, die Maxwellsche Behauptung zu prüfen, nach der die Polarisationserscheinung eines Dielektrikums von einer magnetischen Wirkung in den umgebenden Teilen begleitet ist. Bei den dort beschriebenen Versuchen wurde ein wechselndes elektrisches Feld zwischen zwei cylindrischen Messingringen erregt und ein wechselndes Magnetfeld von gleicher Frequenz und eigener Phase senkrecht zum elektrischen Feld vermittels einer Spule erzeugt, welche zu den Ringen konzentrisch war und den äusseren Ring einschloss. Zwei Klumpen aus der isolierenden Substanz wurden an den entgegengesetzten Enden eines leichten Glasarmes befestigt, der in seinem Mittelpunkte an einem Quarzfaden hing, so dass die Klumpen zwischen den Ringelektroden schwebten. Das resultierende Drehungsmoment liess sich durch die Ablenkung des Armes messen, wenn man die Konstanten der Quarzaufhängung benutzte. Wie der zu erwartende Effekt berechnet wurde, ist in der früheren Arbeit angegeben. Die Ergebnisse der Versuche waren gleichmässig negativ.

Während die Elektrodenringe bei der früheren Arbeit sorgfältig gedreht und so genau wie möglich centriert waren, liessen sich Veränderungen in der Verteilung des elektrischen Feldes feststellen, und aus diesem Grunde nahmen die Stücke isolierender Substanz bei eingeschaltetem elektrischem Felde eine Nullstellung ein, die ganz unabhängig war von der Nullstellung, welche der Torsion des Fadens entsprach. Auch die Elektrodenringe aus Messing waren erheblichen Wärmewirkungen durch Foucaultströme ausgesetzt, welche unsymmetrische Ausdehnungen und störende Luftströme verursachten. Aus diesem Grunde wurden weitere Versuche mit zwei verbesserten Apparatformen ausgeführt. Das Dielektrikum erhielt die Form eines vollständigen Ringes, der zwischen die Elektroden hineinpasste und am Mittelpunkte aufgehängt war; auf diese Weise wurde die Wirkung von kleinen Veränderungen der Feldstärke vermieden. Infolge der Vergrösserung der Masse erhielt man auch im ganzen stärkere Verschiebungsströme und ein grösseres Drehungsmoment; die Benutzung der Quarzaufhängung war jedoch nunmehr unmöglich. Ich benutzte den dünnsten erhältlichen Stahldraht, bei dem, wie ich zeigen werde, die Verminderung der Empfindlichkeit infolge des grösseren Durchmessers nicht erheblich war. Eine zweite Spule für das Magnetfeld wurde innerhalb des inneren Elektrodenringes angebracht, wodurch die Feldstärke erhöht wurde. Die Elektrodenringe bestanden aus Hartgummi mit einem dünnen Schild aus Messingblech, wodurch die Foucaultströme vermindert wurden.

Der dielektrische Ring bestand aus Hartgummi und besass einen mittleren Durchmesser von 22,2 cm; Wandstärke 0,63 cm; Vorderseite 5 cm. Der Raum zwischen den Elektrodenringen betrug 1,26 cm. Die Intensität des Magnetfeldes zwischen den Elektroden war, wie die Messung ergab, $H = 680$. Die gesamte Stromstärke wurde wie in der früheren Arbeit berechnet, und betrug bei einer Spannung von 10000 Volt an den Elektroden und einer Frequenz von 133 Cyklen pro Sekunde $q = 3,9 \times 10^{-4}\,x$ Ampères. Der Stahldraht, der zur Aufhängung benutzt wurde, war vom Kaliber 42 B. & S. (Durchmesser = 0,0062 cm); seine Länge betrug 100 cm. Der Torsionskoeffizient wurde nach der Schwingungsmethode bestimmt. Die gemessene Ablenkung betrug 400 mm auf einer Skala aus Mattglas in der Entfernung 140 cm. Es wurden eine grosse Anzahl Ablesungen unter verschiedenartigen Bedingungen vorgenommen, deren Ergebnisse durchweg negativ waren.

Die eben beschriebene Anordnung war infolge der bedeutenden Masse des Ablenkungssystems und der elektrostatischen Anziehung an die Seiten des Ringes immer noch der Möglichkeit einer erheblichen Störung ausgesetzt, und aus diesem Grunde entwarf ich eine weitere verbesserte Anordnung. Bei dieser bleibt das Prinzip dasselbe, nur dass an Stelle des Torsionsfadens zur Feststellung des Drehungsmomentes eine Messerschneide benutzt wurde; der ganze Apparat wurde nicht in einer Horizontal-, sondern in einer Vertikalebene aufgestellt. Der Vorteil dieser Anordnung besteht darin, dass die Wirkungen aller äusseren Störungen, wie z. B. Luftzug, elektrostatische Anziehung u. s. w., so gut wie eliminiert werden, da sich der Ring nur rotierend um seine Achse bewegen kann. Der Nachteil ist der, dass die Wage weit weniger empfindlich ist, als der Torsionsdraht. Aus diesem Grunde wurde es nötig, die Dimensionen des Apparates zu vergrössern, um so die Wirkung gegenüber dem schon früher berechneten Effekt bedeutend zu erhöhen. Ein besonders konstruierter Hartgummiring mit einer Wagenscheide und Wagschale aus Achat kam zur Verwendung. Das Wagensystem besass eine Empfindlichkeit von $^1/_{30}$ Milligramm und das berechnete Drehungsmoment war zehnmal so gross. Verschiedene Versuchsreihen nach verschiedenen Methoden ergaben negative Resultate.

Die negativen Ergebnisse beider Versuchssysteme könnten wie eine Widerlegung der Maxwellschen Behauptung aussehen. In Anbetracht der ausserordentlichen Menge indirekter Beweise für die Richtigkeit anderer Schlussfolgerungen der Maxwellschen Theorie hat der Verfasser jedoch niemals die Absicht gehabt, vorliegende Arbeit als Beweis einer derartigen Behauptung einzustellen. Er hat vielmehr sich viel lieber zu der Annahme verstanden, dass die Maxwellschen Gleichungen einer weiteren Abänderung oder Auslegung fähig sind und dass die im obigen angeführten Resultate mit denselben immer noch im Einklang stehen. Dass dem wirklich so ist, ist kürzlich von F. Kolaček (diese Zeitschrift **5**, 45, 1904) dargelegt worden. In dieser Arbeit ist darauf hingewiesen, dass die magnetische Wirkung einer elektrischen Verschiebung bei den Versuchen des Verfassers durch die elektrische Wirkung einer Art magnetischer Verschiebung neutralisiert würde, deren Wert er berechnet, so dass die negativen Ergebnisse immer noch mit der Maxwellschen Theorie im Einklange stehen.

Der Röntgensche Versuch, eine magnetische Wirkung elektrischer Verschiebung festzustellen, ist kürzlich mit zweifellos positiven Ergebnissen durch Eichenwald (Annalen der Physik **6**, 1903) wiederholt worden. Wenn wir dieses Ergebnis acceptieren, so haben wir in den Ergebnissen des vorliegenden Versuches einen Beweis für das Vorhandensein einer elektrischen Wirkung magnetischer Verschiebung.

Um die beiden Effekte voneinander zu

trennen, hat Verfasser den von Kolaček angeregten Versuch begonnen, nach dem eine ballistische Ablenkung des Dielektrikums bei konstant erhaltenem elektrischen Feld und bei umgekehrtem Magnetfelde gesucht wird.

Die Versuche wurden im physikalischen Laboratorium der Johns Hopkins Universität mit einem Stipendium der Carnegie-Institution ausgeführt.

(Aus dem Englischen übersetzt von A. Gradenwitz.)

(Eingegangen 7. März 1904.)

PHYSIKALISCHE ZEITSCHRIFT, 6, 474 (1905)

Über den magnetischen Effekt der elektrischen Verschiebung.

Von J. B. Whitehead.

I. Teil.

In zwei früheren Arbeiten[1]) habe ich eine Reihe von Versuchen beschrieben, welche ich angestellt hatte, um die Gültigkeit der Maxwellschen Annahme zu prüfen, daß in Be-

1) Magnetic Effect of Electric Displacement. Report to Carnegie Institution, 1904. — Diese Zeitschr. 4, 229, 1903; 5, 300, 1904.

gleitung einer elektrischen Verschiebung in einem Dielektrikum ein magnetischer Effekt auftritt. Kolacek[1]) hat gezeigt, daß die Versuchsergebnisse mit der Maxwellschen Theorie im Einklang standen. Auf Grund der Symmetrie der Maxwellschen Gleichungen muß man auch das Auftreten eines elektrischen Effektes oder einer elektrischen Kraft als Begleiterscheinung einer magnetischen Verschiebung (wenn man diese analoge Bezeichnungsweise anwenden darf) erwarten. Bei meinen Versuchen war nun, wie Kolacek gezeigt hat, die auf das Dielektrikum wirkende resultierende mechanische Kraft

$$\frac{K}{4\pi v}\frac{\partial}{\partial t}ZM;$$

hier bedeutet K die Dielektrizitätskonstante, v das Verhältnis der Einheiten in den beiden Maßsystemen, Z die elektrische Intensität in elektrostatischen und M die magnetische Intensität in elektromagnetischen Einheiten. Bei meinen Versuchen waren nun sowohl Z als auch M periodische Funktionen mit einer Phasendifferenz von 90°; der Mittelwert der Kraft über eine halbe Periode war daher Null, und somit trat keine Bewegung des Dielektrikums auf. Dieses Ergebnis ist dann ein Beweis für das Vorhandensein des elektrischen Effektes des „magnetischen Verschiebungsstromes", sofern der magnetische Effekt der elektrischen Verschiebung zugestanden wird. Einen Beweis für das Vorhandensein des letzteren hat kürzlich Eichenwald[2]) gegeben, wenngleich viele andere Forscher ihn mit negativem Erfolg gesucht haben. Weitere Beweise erscheinen daher wünschenswert, und so unternahm ich denn diese Arbeit mit der Absicht, die beiden Effekte unabhängig voneinander zu beobachten.

Um direkt den magnetischen Effekt der dielektrischen Verschiebung zu zeigen, entwarf ich die folgende Versuchsanordnung:

Wird ein Teil eines Dielektrikums einem elektrischen Wechselfelde ausgesetzt, so werden in dem Dielektrikum wechselnde Verschiebungsströme erregt werden. Ist nun das Dielektrikum in geeigneter Weise von einem Magnetkreis umgeben, so wird in diesem eine wechselnde magnetische Induktion erregt werden, und wenn dieser Magnetkreis mit einer Anzahl von Drahtwindungen umgeben ist, so wird in diesen Windungen eine wechselnde elektromotorische Kraft induziert werden, welche ihrerseits wieder einen Strom erzeugen kann. Man kann den Wert dieses Stromes berechnen und messen. In der ausgeführten Konstruktion war das Dielektrikum ein Paraffinzylinder. Die elektromotorische Kraft wurde den Elektroden zugeführt, welche aus kreisförmigen Messingplatten an den Endflächen des Zylinders bestanden. Der Zylinder war konzentrisch von einem aus Scheiben von weichem Eisen lamellar zusammengesetzten Magnetkreis umgeben; um den so gebildeten festen Eisenring war eine Wicklung gelegt, welche als die Sekundärwicklung bezeichnet werden mag. Mit dieser Wicklung war das Meßinstrument in Serie geschaltet.

Eine Überschlagsrechnung ergab, daß man, um den erwarteten Effekt wahrzunehmen, die Abmessungen des Apparates groß zu wählen habe, und daß man ferner in der Lage sein müsse, sehr kleine Wechselstromwerte zu messen.

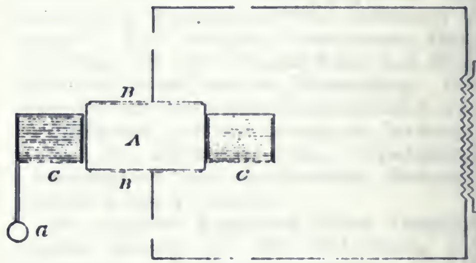


Fig. 1.

Die Figur zeigt den Apparat im mittleren Durchschnitt. A ist der Zylinder aus dem Dielektrikum, BB sind die Elektroden, CC bezeichnen den umgebenden Magnetkreis. Ist E die Potentialdifferenz zwischen den Elektroden und l die Länge des Zylinders, so ist E/l die an dem Dielektrikum wirkende elektrische Intensität. Die Dichte des Verschiebungsstromes ist dann:

$$q = \frac{K}{4\pi l}\frac{dE}{dt}.$$

Ist nun

$$E = E_m \sin\alpha,$$

so ist

$$q = \frac{K}{4\pi l} E_m \cos\alpha \frac{d\alpha}{dt},$$

und da

$$\frac{d\alpha}{dt} = 2\pi N,$$

so folgt:

$$q = \frac{K}{4\pi l} E_m 2\pi N \cos\alpha.$$

Ist a der Flächeninhalt des Zylinderquerschnittes, so ist der Gesamtstrom:

$$i = \frac{K E_m N a}{2l}\cos\alpha,$$

und wenn E_m in Volt und i in Amp. ausgedrückt wird:

1) Diese Zeitschr. 5, 45, 1904.
2) Ann. d. Phys. (4) 6, 1903.

$$i = \frac{K E_m N a \, 10^8}{2l(3 \cdot 10^{10})^2 \cdot 10^{-1}} \cos \alpha .$$

Bei den Versuchen war nun:

$K = 2$,
$E_m = \sqrt{2} \cdot 25000$,
$N = 133$,
$a = \pi \cdot 19{,}25^2 = 1164 \text{ cm}^2$,
$l = 20 \text{ cm}$.

Somit war die maximale Stromstärke:

$$i = \frac{2 \cdot 25000 \cdot 133 \cdot 1164 \cdot 10^8 \sqrt{2}}{2 \cdot 9 \cdot 10^{19} \cdot 20} = 3{,}03 \cdot 10^{-4} \text{ Amp.},$$

$$i_{eff} = 2{,}15 \cdot 10^{-4} \text{ Amp.}$$

Der magnetische Effekt dieses Stromes in einem umgebenden Magnetkreis wird von der Stromverteilung im Dielektrikum abhängen. Die nächstliegende Annahme ist die, daß der Effekt derselbe ist, als wenn der ganze Strom in der Mitte, das heißt auf der Achse des Zylinders, konzentriert wäre. Dann kann man die magnetische Intensität in irgendeiner Entfernung von dieser Achse berechnen unter der Annahme, daß die zu den Elektroden führenden Zuleitungsdrähte und das Dielektrikum einem längs der Achse des Apparates orientierten langen geraden Konduktor äquivalent sind. Demgemäß wurden die Zuführungsdrähte lang und gerade gewählt. Wir haben dann:

Maximalwert von H, der magnetischen Kraft in einem Radius von 20 cm:

$$\frac{2i}{20} = 3{,}03 \cdot 10^{-6},$$

in einem Radius von 40 cm:

$$H = 1{,}51 \cdot 10^{-6}.$$

Bei der ausgeführten Konstruktion bestand der Magnetkreis aus ausgeglühten ringförmigen Armatur-Eisenblechen von 41,4 cm innerem und 82,8 cm äußerem Durchmesser. Nachdem die Bleche aufgeschichtet und zusammengepreßt waren, war die Höhe 15,5 cm; der Querschnitt betrug somit 320 cm². Das Gewicht betrug 900 Pfund englisch (408,3 kg. Der Übers.). Als Durchschnittswert für H kann man dann $2{,}26 \cdot 10^{-6}$ annehmen. Die Zuleitungen zu den Elektroden verliefen beiderseits 100 cm weit geradlinig. Sie bogen dann in rechtem Winkel um und führten parallel miteinander zu dem 5 m entfernten Transformator. Es läßt sich leicht zeigen, daß der Korrektionsfaktor für diese Abweichung von einem unendlich langen geraden Konduktor nur $0{,}09 \frac{i}{r}$ beträgt für die magnetische Kraft, wie sie sich aus dem Ausdruck $H = \frac{2i}{r}$ berechnet. Der Mittelwert ist also $H = 2{,}09 \frac{i}{r}$. Setzt man die oben gegebenen Werte für i und r ein, so wird der Mittelwert

$$H = 2{,}36 \cdot 10^{-6},$$

also die gesamte magnetische Induktion

$$= 2{,}36 \cdot 10^{-6} \cdot \mu \cdot 320.$$

Angaben über die Permeabilität weichen Eisens in Lamellen bei so niedrigen Werten der magnetischen Intensität sind nur spärlich vorhanden

Werte von μ für kleine Magnetisierungskräfte sind bestimmt worden von Baur [1]) und Lord Rayleigh. [2]) Letzterer setzte das Feld von $4 \cdot 10^{-2}$ bis auf $4 \cdot 10^{-5}$ herab und zeigte, daß innerhalb dieses ganzen Gebietes μ konstant ist. Es sind keine Anzeigen dafür vorhanden, daß μ sich für Werte von H verändern würde, die noch näher an O liegen. Dieser Wert beträgt für weiches Eisen, mit konstanter magnetischer Kraft an Barren bestimmt, 183. Ewing hat festgestellt, daß bei Lamellenstruktur keine, oder doch nur geringe Viskosität oder Verzögerung bei kleinen Kräften auftritt.

Nehmen wir diesen Wert an, so haben wir:

$$\text{Gesamtinduktion} = 2{,}36 \cdot 10^{-6} \cdot 320 \cdot 183 = 1{,}35 \cdot 10^{-1}.$$

Den magnetischen Kreis umgab vollständig eine Sekundärwicklung von 966 Windungen aus der Drahtsorte Nr. 18 B. & S. Später wurde über diese eine ähnliche Wicklung von der gleichen Windungszahl so gewickelt, daß beide Spulen im gleichen Punkte anfingen und endigten. Die in einer dieser Wicklungen induzierte elektromotorische Kraft ist:

$$E = 1{,}35 \cdot 10^{-1} \cdot \sqrt{2} \cdot \pi \cdot 133 \cdot 10^{-8} \cdot 966 \text{ Volt} = 7{,}8 \cdot 10^{-4} \text{ Volt}.$$

Kann man einen durch diese elektromotorische Kraft hervorgerufenen Strom messen, so hat man einen Beweis für die Gültigkeit der den schon angeführten Annahmen zugrunde liegenden Theorie. Als Meßinstrument benutzte ich das Rubenssche Vibrationsgalvanometer. [3]) Das Prinzip dieses Instrumentes beruht auf der Abgleichung der Spannung eines gestreckten Drahtes, so daß die Frequenz der Eigenschwingungen desselben die gleiche ist wie die des elektrischen Kreises. Der Draht trägt eine Reihe kleiner Magnete; dieselben entsprechen Polen mit Spulen, die von dem zu messenden Strome durchflossen werden. Die Amplitude der Schwingung wird beobachtet an dem Licht, welches von einem kleinen an dem Drahte befestigten Spiegel reflektiert wird, und ist ein Maß für die Stromstärke. Das Instrument wurde von W. Oehmke-Berlin bezogen und war nach den besonderen Angaben gefertigt worden, die in der bereits angezogenen Veröffentlichung enthalten sind. Die Kalibrierung geschah nach folgender Methode. Eine alternierende elektromotorische Kraft von geringem Betrage und von

1) Wied. Ann. 11, 399, 1880.
2) Phil. Mag., März 1887.
3) Wied. Ann. 56, 27, 1895.

der anzuwendenden Frequenz wurde an einen induktionsfreien Widerstand von 2000 Ohm gelegt. An zwei um 200 Ω auseinander liegenden Punkten wurden Verbindungen angelegt und zwischen dieselben das Galvanometer in Serie mit einem großen induktionsfreien Widerstand von 10000 bis 100000 Ohm geschaltet. Das Galvanometer wurde auf die Frequenz synchron abgestimmt, und es wurde abgelesen, um wieviel verbreitert ein von einem Spalt stammendes Lichtbündel entsprechend den verschiedenen Werten der Stromstärke von dem Spiegel reflektiert wurde. Als Lichtquelle benutzte ich den Faden einer Glühlampe. Die Verbreiterung des Bildes wurde an einem Okularmaßstabe im Fernrohr bestimmt, welcher Ablesungen auf ein Zehntel gestattete. Die Kalibrierungskurve, wie sie durch die Zahlen der folgenden Tabelle gegeben ist, erstreckt sich über das ganze Gebiet der Experimente. Der Widerstand des Instrumentes betrug 215 Ohm.

Amp.	Ablenkung
$4 \cdot 10^{-5}$	4,2
$2 \cdot 10^{-5}$	2,1
$1 \cdot 10^{-5}$	1,2
$6{,}6 \cdot 10^{-6}$	0,95
$5 \cdot 10^{-6}$	0,8
$4 \cdot 10^{-6}$	0,7
$3{,}3 \cdot 10^{-6}$	0,6
$2{,}8 \cdot 10^{-6}$	0,55
$2{,}5 \cdot 10^{-6}$	0,5
$2{,}2 \cdot 10^{-6}$	0,45
$2 \cdot 10^{-6}$	0,4.

Wird nun das Instrument mit der Sekundärwindung ($r = 13$ Ohm) verbunden, so muß nach den obigen Berechnungen die Größenordnung des resultierenden Stromes $\frac{7{,}8 \cdot 10^{-5}}{228} = 3{,}42 \cdot 10^{-6}$ Amp. betragen.

Die Versuche.

Die Stromquelle war ein achtpoliger, einphasiger Alternator, welcher bei einem Effektivwerte von 110 Volt eine angenäherte Sinuskurve für die elektromotorische Kraft lieferte. Sie wurde direkt mit einem mit 110 Volt mittlerer Spannung gespeisten Gleichstrommotor verbunden. Ein schweres Schwungrad auf der Achse und Rheostaten im Felde und der Armatur des Motors, welche vom Standpunkte des Beobachters aus kontrolliert wurden, ließen eine genügende Konstanz und Kontrolle der Frequenz erreichen. Die Wechselstrommaschine speiste die Primäre eines Hochspannungstransformators vom Übersetzungsverhältnis 100/25000, dessen Hochspannungsklemmen mit den Elektroden verbunden waren. Der Transformator befand sich 5 m vom eigentlichen Apparat entfernt und die Verbindungsdrähte liefen parallel und 2,5 cm voneinander entfernt, bis sie die Achse des Apparates schnitten. Die untere Elektrode trug das Paraffin, die obere lag auf demselben. Das Galvanometer war nahe am magnetischen Kreis, und geeignete Kontrollversuche zeigten, daß es frei war von elektromagnetischen Störungen, welche herrührten vom Alternator, vom Transformator usw. Zwischen die Sekundärwicklung und das Galvanometer wurde ein Umschalter eingeschaltet, desgleichen ein einpoliger Schlüssel, welcher nur eine Seite des Stromkreises öffnete. Ein kleines Solenoid wurde in die Nähe des Galvanometers gebracht und von der Maschine gespeist; es diente zur Kontrolle für den Synchronismus und die Konstanz der Versuchsbedingungen. Die beschriebene Apparatur gestattet eine vielfache Abänderung der Versuchsbedingungen mit verschiedenen zu erwartenden Werten der Stromstärke im Galvanometer. Als Dielektrikum können Paraffin und Luft benutzt werden. Die Sekundärspulen können einzeln, hintereinander und parallel geschaltet werden. Verschiedene Werte für die Spannung und die Frequenz benutzte ich nicht, da mit diesen Werten sich wahrscheinlich auch die Fehler ändern würden.

Die folgende Tabelle gibt eine typische Reihe von Ablesungen wieder.

Diese Ablesungswerte blieben unverändert, wenn die Galvanometerzuleitungen vertauscht wurden. Primärspannung 113. Frequenz 130.

Die Beobachtungsmethode war die folgende: mittels des Rheostaten im Motorfelde brachte ich die Geschwindigkeit allmählich auf die gewünschte Frequenz. Diese zeigte sich durch die Verbreiterung des Bildes des Glühlampenfadens auf der Fernrohrskala. Ich ließ dann die Maschine frei laufen, und die Bedingung des vollkommenen Synchronismus blieb in der Regel während mehrerer Sekunden, oft auch länger, bestehen; sie pflegte dann einige Sekunden lang auszusetzen und darauf wiederzukehren. Die angegebenen Ablesungen re-

Sekundärspulen	Paraffin					Luft				
Spule Nr. 1, Nr. 2 geöffnet	0,8	0,8	0,9	0,8	0,82	0,6	0,6	0,6	0,5	0,57
" " 1, " 2 geschlossen	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
" " 2, " 1 geöffnet	0,8	0,9	0,9	0,8	0,85	0,6	0,6	0,6	0,6	0,6
" " 2, " 1 geschlossen	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
" " 1 und Nr. 2 in Serie	1,3	1,3	1,3	1,4	1,32	0,9	0,9	0,9	0,8	0,87
" " 1 " " 2 parallel	0,7	0,75	0,8	0,8	0,76	0,5	0,5	0,5	0,6	0,52

räsentieren in jedem Falle die Beobachtungen von mindestens drei dieser wiederkehrenden Perioden des Synchronismus. Es wurden an verschiedenen Tagen Beobachtungen gemacht und zwischen je zwei Beobachtungsreihen das Paraffin zum Zwecke der Ablesung mit Luft entfernt. Diese Beobachtungen lieferten Ablesungen, welche mit denen in der Tabelle gut übereinstimmen.

Man ersieht, daß die mit Luft als Dielektrikum erhaltenen Werte durchgängig niedriger sind als die mit Paraffin gefundenen, wie es zu erwarten war. Die Werte differieren jedoch nicht im gleichen Verhältnis wie die Dielektrizitätskonstanten. Angesichts der Unsicherheit der Werte dieser Konstanten bei den angewandten Frequenzen und der Unsicherheit der Verteilung des Feldes in beiden Fällen erscheint diese Diskrepanz nicht schwerwiegend. Wichtiger jedoch ist die Tatsache, daß die Reihenschaltung der beiden Sekundärspulen nicht eine Verdoppelung des Wertes der für jede der beiden Spulen allein erhaltenen Ablesung herbeiführt, wenn der Wert auch merklich größer ist. Die Möglichkeit einer Erklärung ist gegeben durch die Art, in welcher die Windungen der beiden Spulen angeordnet sind. Wie schon erwähnt, waren diese beiden Spulen parallel in einer einzigen Lage gewickelt. Werden sie daher hintereinander geschaltet, so besteht zwischen jedem Drähtepaar die Hälfte der gesamten induzierten elektromotorischen Kraft. Dieser Unterschied im Potential wird die symmetrische und gleichmäßige Schwingung der auf der Sekundärspule induzierten elektrostatischen Ladungen zu stören suchen und so zu einem Äquivalent eines Stromes führen, welcher eine zweite induzierte elektromotorische Kraft in der Sekundärwicklung erzeugt. Dies wird bei Parallelschaltung nicht eintreten, eine Ansicht, welcher die Ablesungen entsprechen.

Daß diese elektrostatischen Ladungen keinen Fehler in den Ablesungen herbeiführen, zeigt sich an den Beobachtungen mit „geschlossenen" Spulen, welche in der Tabelle angegeben sind. Der Kurzschluß einer Spule vernichtete stets die elektromotorische Kraft in der anderen. Daraus erhellt, daß der Strom im Galvanometerkreis elektromagnetisch induziert und nicht elektrostatischen Ursprungs ist. Abgesehen von diesem Umstande gibt die symmetrische Form und Anordnung des Apparates keine Veranlassung zu einer unsymmetrischen Schwingung der induzierten Ladungen.

Schlußfolgerung.

Der für eine Spule mit Berücksichtigung der Versuchsbedingungen, d. h. 113 Volt und 130 Touren, berechnete Effekt ist $3,16 \cdot 10^{-6}$ Amp. Die Stromstärke, welche dem Mittelwert (0,82) der Ablenkungen für die Spule Nr. 1 nach den Angaben der Kalibrierungskurve entspricht, ist etwa $5,2 \cdot 10^{-6}$. Der beobachtete Effekt ist also von der gleichen Größenordnung wie der berechnete; durch die Unsicherheit der gemachten Annahmen kann die Differenz zwischen den numerischen Werten wohl erklärt werden.

II. Teil.

Kolacek hat folgende Modifikation meines früheren Versuches[1]) vorgeschlagen, um den elektrischen Effekt der magnetischen Verschiebung zu zeigen. Bringen wir das Dielektrikum in ein konstantes elektrisches Feld und ein dazu rechtwinkliges magnetisches Feld, und kehren wir dann plötzlich die Richtung des magnetischen Feldes um, so sollten wir nach der Maxwellschen Theorie erwarten, daß auf das Dielektrikum ein Kraftstoß wirkt. Der Ausdruck für die Kraft wird jetzt

$$\frac{K}{4\pi v} Z \frac{\partial}{\partial t} M,$$

denn Z ist eine Konstante, d. h. es ist kein elektrischer Verschiebungsstrom vorhanden. Dieses Experiment bietet nach Kolacek auch das Mittel zur Prüfung der von Lorentz vorgeschlagenen Modifikationen der Maxwellschen Theorie. Maxwell drückt den Wert des Verschiebungsstromes aus durch die Formel

$$\frac{K}{4\pi} \frac{\partial Z}{\partial t}$$

und sagt über den Mechanismus im Dielektrikum nichts aus, als daß das Anwachsen oder Nachlassen der elektrischen Spannung oder Polarisation in einem Dielektrikum von der spezifischen induktiven Kapazität K der magnetischen Wirkung nach äquivalent ist einem Strom von der Dichte

$$\frac{K}{4\pi}\left(\frac{\partial Z}{\partial t}\right).$$

Lorentz dagegen nimmt an, daß sich der Verschiebungsstrom aus zwei Teilen zusammensetzt, erstens der Polarisation des Äthers und zweitens den Verschiebungen der Atom- oder Ionenladungen innerhalb der Moleküle des Dielektrikums; diese Verschiebungen seien wirkliche Bewegungen von Ladungen und als solche äquivalent mit Strömen, und somit sei der Maxwellsche Ausdruck

$$\frac{K}{4\pi}\left(\frac{\partial Z}{\partial t}\right)$$

gleichbedeutend mit

$$\frac{1}{4\pi}\left(K_e + \Sigma c\right)\frac{\partial Z}{\partial t},$$

1) Diese Zeitschr. 4, 229, 1903.

wo K_e der Wert von K für den Äther und Σc die Summe über die molekularen Konvektionsströme ist. Diese Annahme gibt das Vorhandensein des magnetischen Effektes der elektrischen Verschiebung zu. Nun ist aber bei der vorgeschlagenen Versuchsanordnung, bei welcher nach Maxwell eine Ablenkung zu erwarten wäre, das elektrische Feld konstant, und die Verschiebungsströme fehlen. Nach Lorentz würde also nur eine Reaktion auf den Äther auftreten, welche keine Ablenkung des Dielektrikums verursachen würde.[1]) Diese Schlußfolgerung hat R. Gans[2]) in Zweifel gezogen. Er schließt nämlich, daß nach Lorentz eine Ablenkung zu erwarten sei, daß ihr Wert aber $\frac{K-1}{K}$ mal so groß sein würde, wie der aus der ursprünglichen Maxwellschen Theorie sich ergebende Wert.

Eine Berechnung der Größe des Kraftimpulses für einen spezifischen Fall ergab, wie weiter unten ausgeführt werden wird, daß derselbe so klein sein würde, daß seine direkte Beobachtung schwierig, wenn nicht gar ununmöglich, sein würde. Nichtsdestoweniger entschloß ich mich, den Versuch unter möglichst günstigen Bedingungen auszuführen, um zu sehen, wie nahe ich unter möglichster Erhöhung der verschiedenen Faktoren an den berechneten Effekt würde herankommen können.

Der Apparat.

Als Dielektrikum verwandte ich einen Steinsalzwürfel von 1 cm Kantenlänge. Dieser war anfangs zwischen zwei vertikalen parallelen Platten von verschiedenem Potential aufgehängt. Es ergab sich, daß das Dielektrikum bei dieser Anordnung wegen der unregelmäßigen Feldverteilung keine Gleichgewichtslage besaß. Ich wandte deshalb die in Figur 2 angegebene Versuchsanordnung an. Das Dielektrikum D war an der Mitte eines leichten Glasstabes befestigt, welcher an zwei Seidenfäden derart aufgehängt war, daß er in der Achse einer kreisrunden Spule C hing, welche in der Figur im Durchschnitt gezeichnet ist. Über und unter dem Dielektrikum waren zwei parallele Messingplatten A und B angeordnet. Dieselben waren in geeigneter Weise unterstützt und isoliert und dienten als Elektroden. Auf diese Weise hing das Dielektrikum in einem von der Spule erzeugten magnetischen Feld und in einem von den Elektroden herrührenden zu dem magnetischen senkrechten elektrischen Feld. Das Experiment verläuft nun so, daß die magnetische Feldrichtung umgekehrt und dabei das elektrische Feld konstant gehalten wird. Dabei wird beobachtet, ob eine ballistische Ablenkung des Dielektrikums auftritt. Die an dem Dielektrikum wirkende Kraft ist, wie bereits festgestellt,

$$\frac{K}{4\pi} Z \frac{\partial}{\partial t} M,$$

wo K die Dielektrizitätskonstante, Z die elektrische und M die magnetische Feldstärke ist. Diese Größen wurden so groß wie möglich gewählt. Als Dielektrikum wurde Steinsalz gewählt und für K der Wert 5 angenommen. Die Spule zur Erregung des Magnetfeldes bestand aus 1200 Windungen der Drahtsorte Nr. 18 B. & S. Ihr innerer Durchmesser und ihre Länge betrugen beide 7,6 cm. Die magnetische Feldstärke im Mittelpunkt wurde mittels einer Prüfspule und Wechselstrom gemessen und zu 166 per Ampère gefunden. Bei den Versuchen wurde die Stromstärke, für welche eine obere Grenze durch die Erwärmung gegeben war, bis auf 6,5 Amp. getrieben. Daraus ergibt sich $M = 1080$. Ich versuchte verschiedene Wege, um die elektrische Intensität im Dielektrikum zu steigern. Ich bedeckte die obere und die untere Fläche des Dielektrikums mit Metallfolie, von welcher sich oben und unten je ein schmaler Streifen parallel zu dem tragenden Glasarm erstreckte. Ich entfernte die oben beschriebenen Elektroden und brachte sehr leichte Haken aus feinem Drahte so an, daß sie mit leichtem Drucke den von den Metallbelegungen des Dielektrikums sich erstreckenden Streifen anlagen und so diese Belegungen mit den Polklemmen einer Induktionsmaschine verbanden. Der geringe Druck, welcher von diesen Haken herrührte, war gleichgerichtet mit der erwarteten Ablenkung. Bei Ladung wurden die kleinen Haken statisch abgestoßen. Wurden sie schwerer gemacht, so setzte derselbe Effekt das Dielektrikum in Bewegung. Nach verschiedenen Modifikationen wurde diese Methode als nicht brauchbar verlassen. Ich versuchte dann leichte Drähte, welche von den Metallbelegungen aus in Näpfe mit flüssigen

1) Kulacek, diese Zeitschr. 5, 455, 1901.
2) Diese Zeitschr. 5, 162, 627, 1904.

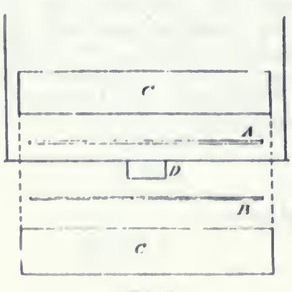


Fig. 2.

Leitern tauchten. Bei dieser Anordnung verhinderten Ungleichmäßigkeiten in der Oberflächenspannung die Aufrechterhaltung konstanter Bedingungen. Ich faßte dann den Plan, das Dielektrikum zwischen horizontalen Elektroden aufzuhängen, dabei die Elektroden so nahe wie möglich aneinander zu bringen und die Potentialdifferenz so hoch wie möglich zu steigern, d. h. so weit, daß bei einem noch höheren Werte eine Entladung eintreten würde. Die Kantenlänge des dielektrischen Würfels betrug 1 cm und die kleinste mit der Aufrechterhaltung konstanter Bedingungen noch vereinbare Entfernung zwischen den Elektroden war 2,2 cm. Die Potentialdifferenz wurde bis auf 15 500 Volt getrieben. Sie wurde mittels einer Funkenstrecke zwischen Messingkugeln gemessen und nach den Tabellen von Paschen[1]) berechnet. Die Empfindlichkeit des Apparates hängt hauptsächlich von der Länge der Aufhängungsfäden ab. Diese bestanden aus sehr dünnen Kokonfäden, und ihre Länge betrug 112 cm. Der ganze Apparat befand sich in einer geeigneten Umhüllung und die Aufhängefäden führten durch besondere Glasröhren.

Wir haben nun folgende Werte für die verschiedenen Größen:

Elektrodenabstand: 2,2 cm; maximale Potentialdifferenz an den Elektroden: $E = 15\,500$ Volt; maximale magnetische Feldstärke: $M = 1080$; Länge der Aufhängung: 112 cm; Kantenlänge des dielektrischen Würfels: 1 cm; Masse des aufgehängten Systems: ungefähr 3 Gramm.

Wir haben dann:

Elektrische Intensität im Dielektrikum:

$$z = \frac{E}{1d + K1a} = \frac{15\,500}{1 + 1{,}2K}.$$

Wird die magnetische Feldrichtung umgekehrt, so ist der erfolgende Stoß an dem Dielektrikum:

$$\int A dt = \frac{K}{4\pi v} Z \int dM = \frac{5}{12{,}5 \cdot 5 \cdot 10^{-10}} \cdot \frac{15\,500 \cdot 10^8}{7} \cdot \frac{2160}{3 \cdot 10^{10}} = 2{,}1 \cdot 10^{-7} \text{ CGS}.$$

Dividieren wir das Moment dieses Impulses durch das Trägheitsmoment des aufgehängten Systems, so erhalten wir die erfolgende Winkelgeschwindigkeit des dielektrischen Würfels. Aus dieser leitet sich seine kinetische Energie und sonach der Bogen ab, um welchen er entgegen der Schwerkraft schwingen wird. Eine Berechnung dieser Größe ergibt eine Ablenkung von der Größenordnung 10^{-6} cm. Dadurch erklären sich nicht nur die übereinstimmend negativen Ergebnisse der Untersuchungen, sondern es erhellt auch, daß man aus dem von Kolacek vorgeschlagenen Versuch in dieser Form eine Antwort auf die gestellte Frage nicht erwarten darf.

Diese Untersuchung wurde im physikalischen Laboratorium der John Hopkins-Universität mit den Mitteln der Carnegie-Stiftung ausgeführt.

(Aus dem Englischen übersetzt von Max Iklé.)

(Eingegangen 15. April 1905.)

1) Wied. Ann. **37**, 79, 1889.

1903. № 5.

ANNALEN DER PHYSIK.

VIERTE FOLGE. BAND 11.

1. *Über die magnetischen Wirkungen bewegter Körper im elektrostatischen Felde;*

von A. Eichenwald.

(Hierzu Taf. I, Fig. 1.)

Die elektromagnetischen Erscheinungen, welche bei der Bewegung der Körper eintreten, sind experimentell viel untersucht worden in den Fällen, wo diese Bewegung im magnetischen Felde stattfindet. Über bewegte Körper in einem elektrostatischen Felde haben wir verhältnismäßig noch sehr wenig Erfahrung. Deshalb habe ich es unternommen, diese letzte Klasse von Erscheinungen, hauptsächlich aber die dabei eintretenden magnetischen Wirkungen, unter möglichst variierten Versuchsbedingungen, experimentell zu studieren.

Der Natur der Sache entsprechend, will ich die Bewegung der Leiter und Dielektrika gesondert behandeln.

I. Bewegte Leiter.

1. Wenn sich Leiter in einem elektrostatischen Felde bewegen, so wird dabei auch die auf ihrer Oberfläche verteilte Ladung mitbewegt; es entsteht sogenannte „elektrische Konvektion", deren magnetische Wirkung bekanntlich von Rowland[1]) zum ersten Male nachgewiesen worden ist. Seine Versuche wurden von Röntgen[2]) und Himstedt[3]) wiederholt und bestätigt. Himstedt hat zwar nur relative Messungen

1) H. A. Rowland, Sitzungsber. d. k. Akad. d. Wissensch. zu Berlin p. 211. 1876.

2) W. C. Röntgen, Sitzungsber. d. k. Akad. d. Wissensch. zu Berlin p. 198. 1885.

3) F. Himstedt, Wied. Ann. 38. p. 560. 1889.

gemacht, konnte aber die Proportionalität der magnetischen Wirkung mit der Geschwindigkeit und Dichtigkeit der bewegten Ladung in ziemlich weiten Grenzen prüfen. Endlich haben Rowland und Hutchinson[1]) aus den Beobachtungen der magnetischen Wirkung des konvektiven Stromes das Verhältnis der elektrostatischen zu den elektromagnetischen Einheiten berechnet und bekamen einen Wert für das V, welches zwischen $2{,}26 . 10^{+10}$ und $3{,}78 . 10^{+10}$ lag; als Mittelwert aus zwanzig Versuchsreihen ist $3{,}19 . 10^{+10}$ angegeben.

Fast zu derselben Zeit, als ich über einige meiner Versuche kurz berichtet habe[2]), erschien eine schöne und sorgfältig unter der Leitung von H. Rowland selbst ausgeführte Arbeit von H. Pender[3]), in welcher gezeigt wird, daß eine gleichmäßig bewegte, aber veränderliche elektrische Ladung dieselben Induktionswirkungen ausüben kann, wie ein veränderlicher elektrischer Strom; auch in quantitativer Hinsicht ist die Übereinstimmung eine sehr gute (V liegt zwischen $2{,}75 . 10^{10}$ und $3{,}23 . 10^{10}$; Mittelwert $V = 3{,}05 . 10^{10}$). Weiter hat E. Adams[4]) die magnetische Wirkung bei der Bewegung von geladenen Kugeln beobachtet; hier ist die Übereinstimmung mit der Theorie weniger gut, auch die Versuchsanordnung ist nicht ganz einwandsfrei, denn die Kapazität der Kugeln bleibt während der Bewegung nicht konstant. Endlich ist soeben eine zweite Arbeit von H. Pender[5]) erschienen, wo die Genauigkeit der Übereinstimmung der Theorie mit dem Versuche eine noch größere ist; die aus den Versuchen berechnete Lichtgeschwindigkeit liegt zwischen $2{,}92 . 10^{10}$ und $3{,}04 . 10^{10}$ und als Mittelwert wird $3{,}00 . 10^{10}$ angegeben. Dabei variierte die Tourenzahl von 10—102 Umdrehungen in der Sekunde, die Potentialdifferenz von 905—6275 Volts. H. Pender hat auch den Rowlandschen Versuch in seiner ersten Form mit einer horizontalen rotierenden Scheibe mit leitenden Sektoren wiederholt und direkt die Ablenkungen der über die Scheibe

1) H. A. Rowland u. C. T. Hutchinson, Phil. Mag. (5) 27. p. 445. 1889.

2) A. Eichenwald, Physik. Zeitschr. 2. p. 703. 1901.

3) H. Pender, Phil. Mag. (6) 2. p. 179. 1901.

4) E. P. Adams, Phil. Mag. (6) 2. p. 285. 1901.

5) H. Pender, Phil. Mag. (6) 5. p. 34. 1903.

hängenden Nadel beobachtet. Die beobachtete Ablenkung war 47,9; die Rechnung ergab 56,0. Wir können also sagen, daß jetzt die magnetische Wirkung konvektiv bewegter Ladung schon von mehreren Beobachtern bestätigt[1]) worden ist.

Einige von den hier angeführten Versuchen sind also nur als Wiederholungen anzusehen, die mir aber nicht überflüssig schienen, erstens wegen der Wichtigkeit der ganzen Frage und zweitens deshalb, weil alle meine Versuche nach einem einheitlichen Plane ausgeführt worden sind und so in einem gewissen Zusammenhange zueinander stehen. Außerdem muß ich zufügen, daß man in der Litteratur über die Erscheinungen der elektrischen Konvektion zum Teil unrichtige oder wenigstens unklare Ansichten treffen kann, weshalb ich mir erlaube diese Frage eingehender zu behandeln.

2. Bei der Untersuchung des Rowlandeffektes kann man zwei wesentlich verschiedene Methoden benutzen. Bei der einen beobachtet man direkt das magnetische Feld, welches von einer gleichförmig bewegten Ladung erzeugt wird; diese Methode ist von H. Rowland selbst und fast von allen anderen Beobachtern benutzt. Bei der zweiten von H. Pender gewählten Methode[2]), werden die Induktionsströme beobachtet, welche bei der Veränderung des magnetischen Feldes einer mit gleichförmiger Geschwindigkeit bewegten, aber mit der Zeit veränderlichen Ladung erzeugt werden.

Die zweite Methode mag verschiedene Vorteile in Bezug auf Bequemlichkeit der Beobachtung darbieten, ich glaube dennoch der ersten den Vorzug geben zu dürfen, erstens weil

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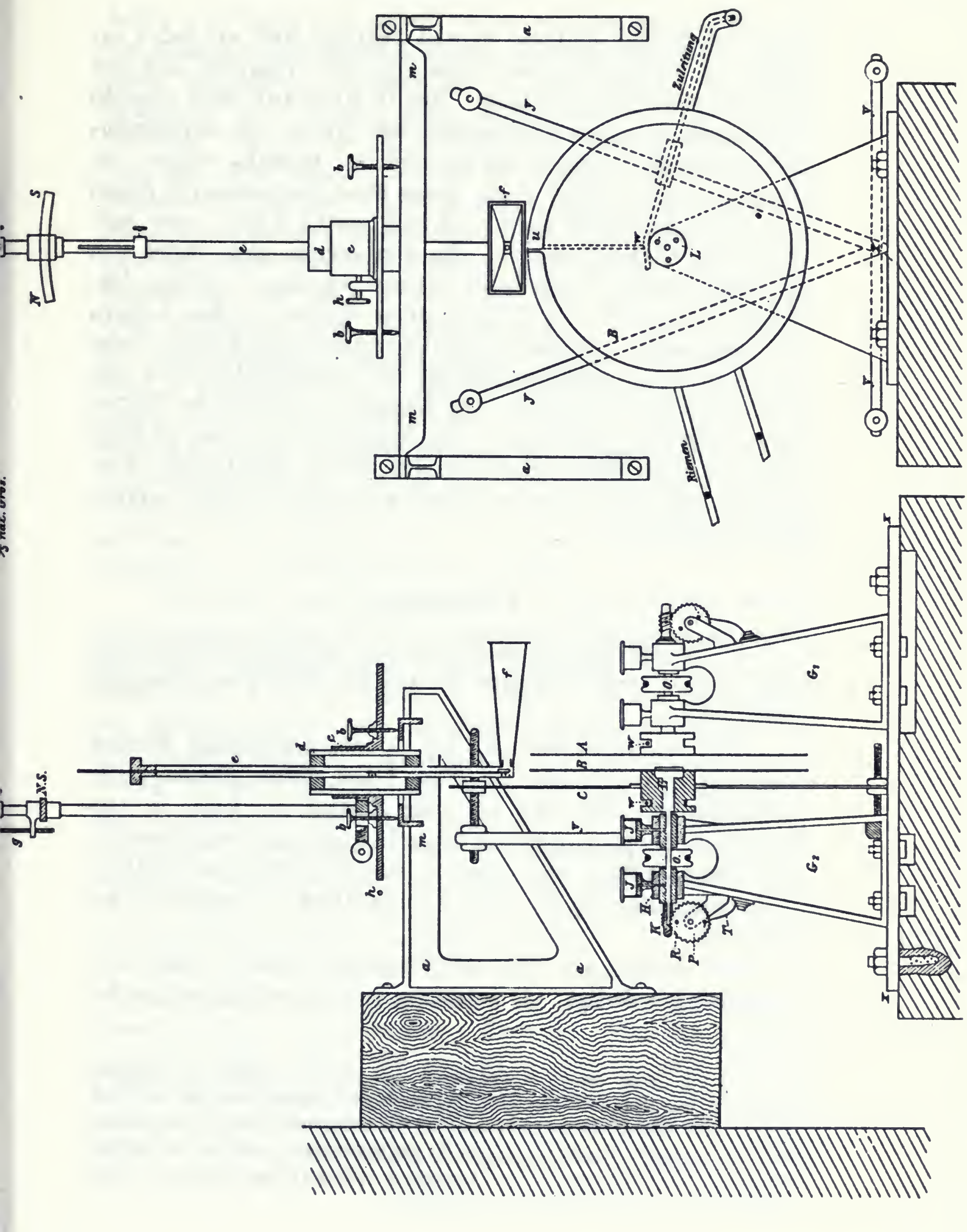
1) Was das Mißlingen dieser Versuche bei V. Crémieu anbetrifft, so muß das offenbar irgend einem Versuchsfehler zugeschrieben werden, welchen hoffentlich Hr. V. Crémieu selbst mit der Zeit auffinden wird. Wenn man bedenkt, wie schwer es manchmal ist, einen Versuchsfehler bei seinen eigenen Versuchen zu finden, so wird man zugeben, daß es noch schwerer ist, solche Fehler nur nach der Beschreibung der Versuche anderer anzuzeigen. Alles, was man in solchen Fällen tun kann, ist, die möglichen Fehlerquellen anzugeben, ohne aber überzeugt zu sein, daß gerade diese und nicht noch andere Fehler bei Hrn. V. Crémieu im Spiele waren.

2) Die Methode ist von V. Crémieu, Compt. rend. 131. p. 797. 1900.


Zuleitung
Riemen

das eine direkte Methode ist und zweitens weil wir dabei nur statische Felder benutzen, was für den Vergleich mit der Theorie von Wichtigkeit ist. Bei H. Rowland wird nämlich ein Leiter in einem elektrostatischen Felde mit unveränderlicher Geschwindigkeit bewegt und es entsteht wieder ein statisches magnetisches Feld. Keine Energieumsetzungen finden bei dieser Bewegung statt. Ich will solche Fälle *„reine elektrische Konvektion"* nennen. Im allgemeinen aber fügen sich bei der Bewegung geladener Körper zu dieser reinen elektrischen Konvektion noch elektrische Ströme in den Leitern und sogenannte Verschiebungsströme in den Dielektrika. Jeder von diesen drei Strömen erzeugt ein magnetisches Feld und in den beiden letzten wird die Energie in Joulesche Wärme und Strahlung verwandelt. Im folgenden soll hauptsächlich nur die magnetische Wirkung der reinen elektrischen Konvektion untersucht werden, aber auch andere Fälle werden kurz behandelt.

Die Apparate.

3. In der Fig. 1, Taf. I, ist eine genaue Zeichnung des Apparates gegeben, welchen ich bei den definitiven Versuchen benutzte.[1])

Zwei solide Stützen G_1 und G_2 aus gegossenem Messing sind mit je vier Bolzen an einer 8 mm dicken Messingplatte XX befestigt. Die eine von den Stützen G_1 kann in verschiedenen Entfernungen von der anderen festgeschraubt werden. An diesen Stützen sind oben die mit Weißmetall ausgefüllten Achsenlager H und die Schmiervorrichtung J (Vaselinfett) angebracht.

Die Achsen KL habe ich früher aus Stabilit (Isolationsmaterial) angefertigt, sie erlaubten mir aber kein langes Ar-

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1) Ich habe meine Vorversuche mit einer einfachen Zentrifugalmaschine angefangen. Der hier beschriebene Apparat ist vom Institutsmechaniker Th. Kotschetow auf das befriedigendste ausgeführt worden und ich will ihm für sein stetiges Entgegenkommen, welches er bei den zahlreichen Umänderungen des Apparates geäußert hat, auch an dieser Stelle meinen besten Dank auszusprechen.

beiten und liefen sich schnell warm, wodurch die Reibung und die Rotation unregelmäßig wurde; Stahlachsen übten eine zu große magnetische Wirkung auf das Magnometer; am besten bewährten sich 6,5 mm dicke Achsen aus hartem Messing (Tombak). Jede Achse ist an einem Ende mit einer Verdickung und mit einer kleinen Scheibe *L* versehen, an welcher die rotierenden Scheiben *A* und *B* angeschraubt werden; in der Mitte zwischen den Achsenlagern sitzt die Riemenscheibe *O*, an dem anderen Ende der Achse ist ein Gewinde *K* angebracht, welches das Zählrad *P* in Bewegung setzt. Da die Zählräder vom Beobachter nicht gut zu sehen sind, so sind an ihnen an zwei diametral gegenüberliegenden Stellen zwei kleine Stiftchen *R* angelötet, welche beim Vorbeigehen an den Kontaktfedern *T* einen Strom schließen und einen besonderen, in der Nähe des Beobachters aufgestellten elektromagnetischen Zähler in Bewegung setzen. Es versteht sich von selbst, daß diese verhältnismäßig starken Ströme bei allen Versuchen so angeordnet und mit Rückleitungen versehen waren, daß sie keine Wirkung auf das Magnetometer ausübten.

Der ganze Rotationsapparat ist an einem 70 cm hohen Steinpfeiler, welcher auf dem Gewölbe des Zimmerbodens steht, mit sechs einzementierten Bolzen befestigt. In einer Entfernung von 4 m von dem Pfeiler steht auch auf dem Boden ein Dreiphasenmotor, der vermittelst eines Schnurriemens mit der Riemenscheibe *O* verbunden ist. Der Motor konnte von 4—24 Touren in der Sekunde machen, die Achse des Rotationsapparates machte entsprechend 25—150 Umdrehungen in der Sekunde. Das Ingangsetzen des Motors in der einen oder anderen Richtung konnte vom Platze des Beobachters aus gemacht werden und der Motor, wie alle seine Zuleitungen übten auch keinen Einfluß auf das Magnetometer.

Einen der wichtigsten Teile des Apparates bilden die beiden rotierenden Scheiben *A* und *B*. Bei den großen Geschwindigkeiten, welche bei diesen Versuchen gebraucht werden, ist es unbedingt nötig, die auf der Achse befestigte Scheibe auf das sorgfältigste auszubalancieren, damit ihr Schwerpunkt möglichst genau mit der Rotationsachse zusammenfällt, sonst erhält man starke Erschütterungen des ganzen Apparates und des Zimmerbodens und schnelles Warmlaufen der Achsenlager; für denselben Zweck fand ich es besser, so wenig als möglich den Achsen in der Längsverschiebung freien Spielraum zu lassen. Da die Scheiben elektrische Ladungen bei ziemlich hohen Potentialen tragen sollen, so müssen sie auch gut von der Achse isoliert sein. Ich habe Scheiben aus verschiedenem Materiel versucht und am besten für diesen Zweck Mikanitscheiben gefunden. Mikanit isoliert sehr gut auch auf seiner Oberfläche (besser als Glas), läßt sich leicht eben machen, wozu man ihn in Papier eingewickelt zwischen zwei schwere, bis auf etwa 100° erwärmte Gußeisenplatten legt und so langsam kalt werden läßt. Er bleibt auch im Verlauf von mehreren Versuchen schön eben (besser als Hartgummi). Die von mir benutzten Mikanitscheiben hatten im Durchmesser 25 cm und waren 0,6 mm dick. Mir stand Mikanit von 1 mm und von 0,3 mm Dicke zur Verfügung; der erste erwies sich als stark magnetisch, der zweite besaß keine genügende Steifigkeit und ich mußte jede rotierende Scheibe aus zwei Mikanitscheiben von 0,3 mm Dicke bilden, welche sich sehr gut mit Schellack zwischen den oben erwähnten heißen Eisenplatten zusammenkleben ließen. Die Mikanitscheiben sind am Rande mit 1,5 cm breiten Stanniolstreifen beklebt, welche an einer Stelle durch einen radialen, 0,5 mm breiten Schlitz unterbrochen sind. Das eine Ende jedes Streifens *U* ist mit dem an der Achse sitzenden, aber von ihr isolierten Schleifringe mit Bürste *W* leitend verbunden; das andere Ende ist bei der Scheibe *A* dauernd mit der Achse, also mit der Erde verbunden, bei der Scheibe *B* bleibt es frei und kann, indem die Scheiben ruhen, durch eine angelegte Feder auch mit der Erde verbunden sein. Bei der Rotation kann also die Scheibe *B* auf ein gewisses Potential geladen werden, während der Ruhe kann durch jeden Streifen ein galvanischer Strom von bekannter Intensität durchgelassen werden.

Auf die Isolation aller Teile wurde besondere Sorgfalt angewandt und es ließ sich dies durch Paraffin und Hartgummi leicht erreichen, was aber am meisten Schwierigkeiten machte, ist die Beseitigung von kleinen Spitzen, die manchmal gar nicht zu finden waren und dennoch die Beobachtung äußerst störten (vgl. unter § 8, e). Meistenteils gelang es, diese Schwierigkeit zu überwinden, indem man die leitenden Oberflächen mit einer sehr dünnen Schicht Paraffin oder Schellack überzog.

Die unbeweglichen Teile des Apparates, wie Scheiben, Schutzringe, Metallhüllen etc. können teils an der Bodenplatte *XX*, teils an zwei an den Stützen angebrachten Messingarmen *Y* festgeschraubt werden.

Die Scheiben rotieren im magnetischen Meridian.

Magnetometer.

4. Um das Magnetsystem möglichst frei von den unvermeidlichen Erschütterungen des Rotationsapparates zu machen, ist das Magnetometer an der Wand befestigt. Zwei Wandkonsolen *aa* sind durch eine Metallplatte *mm* überbrückt, auf welcher die drei Stellschrauben *b* einer vertikalen zylinderischen Metallhülse *c* ruhen. In dieser Metallhülse kann sich eine zweite *d* zusammen mit dem das Magnetsystem enthaltenden Rohr *e* in vertikaler Richtung verschieben lassen. Die Brücke selbst läßt sich auch längs der Konsolen horizontal verschieben und in beliebiger Stellung festklemmen; beide Bewegungen zusammen erlauben dem Magnetsystem verschiedene Stellungen in Bezug auf den Rotationsapparat zu geben. Das Rohr *e* hat einen Durchmesser von 1 cm, eine Wanddicke von 1 mm und ist auf elektrolytischem Wege aus Kupfer hergestellt. Ein Fensterchen von 5×5 mm Öffnung erlaubt die Ablenkungen der Magnetnadel mittels Spiegel und Skala zu beobachten. Der Trichter *f* schützt das Fensterchen vor elektrostatischen Einflüssen. *NS* ist der Astasierungsmagnet mit einer Schraube *g* zur bequemen Astasierung; eine zweite Schraube *h* ermöglicht, den Astasierungsmagnet um eine vertikale Achse langsam zu drehen.

Das Magnetsystem selbst habe ich in verschiedenen Formen benutzt; für die hier unten angeführten Versuche kommen nur zwei von ihnen in Betracht. Das eine (Fig. 2, *a*) besteht aus sechs dünnen Stahllamellen (Uhrfedern) von 3 mm Länge, welche an einem 15 cm langen Glasfaden angekittet waren. Dieses Magnetsystem wird immer höher als der obere Rand der rotierenden Scheiben angebracht, sodaß die bewegte

Ladung größtenteils nur auf die untere Nadel wirken kann. Das andere (Fig. 2, *b*) hat nur zwei Paar Nadeln, die in einer Entfernung von 3 cm voneinander auf dem Glasfaden sitzen. Der geladene Stanniolstreifen bewegt sich zwischen den Nadeln und wirkt auf beide in gleichem Sinne.

Die volle Schwingungsdauer der Nadel war fast bei allen Versuchen ca. 10 Sek.

Die Spiegelchen *O* sind, wie in der Zeichnung (Fig. 2) angegeben, angebracht und haben eine Größe von 2 × 3 mm. — Die Skala ist mit seitlicher Beleuchtung und in Millimeter geteilt; der Skalenabstand gleich 2 m. —

Der ganze Rotationsapparat und das Magnetometer sind dauernd an Erde gelegt.

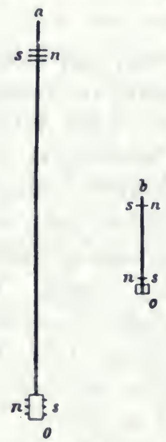

Fig. 2.
1/3 nat. Größe.

Methode.

5. Die Methode, welche hier bei allen Versuchen benutzt wird, ist dieselbe, welche ich schon früher benutzt habe[1]) und besteht darin, daß man zuerst eine geladene leitende Oberfläche, bei uns eine ringförmige Stanniolbelegung, rasch bewegt, also einen Konvektionsstrom erzeugt und dann durch dieselbe Oberfläche einen galvanischen Strom schickt und die magnetischen Wirkungen beider vergleicht. Dadurch wird man fast ganz frei in der Wahl der Lage und des Abstandes des Magnetsystems von den einzelnen Teilen des Rotationsapparates und man braucht diese Abstände gar nicht zu kennen. Das Magnetsystem selbst kann beliebig konstruiert sein; die Dimensionen der Nadeln, ihre gegenseitige Lage und die einzelnen magnetischen Momente jeder zu einem astatischen Paare verbundenen Nadel brauchen nicht bestimmt zu werden. Allerdings kann bei unserer Methode der Einwand erhoben werden, daß die galvanische Stromdichte in der ringförmigen Stanniolbelegung anders verteilt sein kann, als die Elektrizitätsdichte bei der Ladung; ebenso ist die Geschwindigkeit für ver-

1) A. Eichenwald, l. c. p. 704.

schiedene Kreise in Stanniolringe verschieden und zwar ist sie an dem äußeren Rande $^{26}/_{22}$ mal größer als am inneren. Diese Korrektion (in maximo 5 Proz.) wurde annähernd berechnet und an den Beobachtungen mit dem Magnetsystem Fig. 2, *a* angebracht; bei dem kleineren Magnetsystem Fig. 2, *b* hat die Verteilung der Ströme fast gar keinen Einfluß. Alle relativen Messungen werden von diesem Umstande gar nicht beeinflußt.

6. Ist C die Kapazität der bewegten Scheibe und V ihr Potential, so ist CV die Elektrizitätsmenge. Macht die Scheibe n Umdrehungen in der Sekunde, so ist CVn der Konvektionsstrom; schickt man jetzt durch dieselben Belegungen einen bekannten galvanischen Strom i und beobachtet bei dem Konvektionstrome eine Ablenkung des Magnetometers a, bei dem galvanischen Strome eine Ablenkung b, so muß sein

$$\frac{CVn}{a} = \frac{i}{b}.$$

Da man V, n, a, b und i direkt beobachtet, so kann man daraus die Kapazität C berechnen und sie mit der direkt bestimmten Kapazität vergleichen; oder, was zweckmäßiger ist, die nach irgend einer Methode bestimmte Kapazität in die obige Gleichung einsetzen, die Ausschläge a berechnen und sie mit den beobachteten vergleichen. Endlich kann man auch, wie es Rowland getan hat, das Verhältnis der elektrostatischen zu den elektromagnetischen Einheiten berechnen. Die Resultate solcher Berechnungen sind unten an entsprechenden Stellen angegeben.

7. Die Kapazität wurde bestimmt, indem man den Kondensator vermittelst einer Wippe n_1 gleich 22 mal in der Sekunde auf eine Potentialdifferenz von V_1 gleich 55 Volt lud und ebenso oft durch ein Galvanometer von bekannter Empfindlichkeit entlud. Ist der Anschlag des Galvanometers dabei a_1 und gibt er bei einem bekannten Strom i_1, einen Anschlag b_1 so ist

$$\frac{CV_1 n_1}{a_1} = \frac{i_1}{b_1},$$

eine Formel, die ganz analog wie die oben angeführte gebaut ist. Deswegen habe ich auch aus dem Rowlandschen Versuch die Kapazität zu berechnen versucht.

Die Wippe war so konstruiert, daß durch den Galvanometer nur die Ladung der bewegten Teile der geladenen Leiter ging, weil in dem Rowlandschen Versuch nur diese in Betracht kommen, obwohl gleichzeitig auch andere Leiter (z. B. die Schutzringe etc.) mit geladen werden können. Auf dieselbe Weise wurde auch die Kapazität der bewegten, aber mit der Erde verbundenen Leiter bestimmt.

Das Galvanometer war von du Bois und Rubens älterer Konstruktion und gab bei einem Widerstand von 40 Ohm und Skalenabstand von 2 m eine Empfindlichkeit 1 Skt. $= 2{,}10^{-9}$ Amp. Die gemessenen Kapazitäten lagen im Bereiche von $1{,}10^{-11}$ bis $5{,}10^{-11}$ Farad. Für die Ladung wurde immer eine passende Zahl Akkumulatoren genommen, um die Ausschläge von ca. 100 mm zu erhalten. Es wurde noch ein Hülfskondensator mit Schutzring, also von genau berechenbarer Kapazität, zum Vergleich mit den unbekannten Kapazitäten benutzt.

Die Potentialdifferenz V der Scheiben wurde mit einem Braunschen Elektrometer bestimmt, welcher von Zeit zu Zeit mit einem absoluten Elektrometer geeicht wurde. Die Eichung geschah nach der von P. Czermak[1]) angegebenen Methode (mit Telephon), welche ich sehr bequem und zuverlässig fand.

Als Elektrizitätsquelle diente eine Toeplersche Influenzmaschine, welche dauernd mit einer isolierten Batterie von 27 Leydener Flaschen verbunden war. Der bewegliche Kondensator im Rotationsapparat konnte durch eine Wippe mit der einen oder anderen Belegung der Batterie verbunden werden und sich positiv oder negativ laden. Die Kapazität der Batterie war ca. 30000 cm, während die Kapazität der beweglichen und unbeweglichen Teile des Kondensators im Rotationsapparat höchstens 90 cm betrug. Bei jedem Kommutieren sank also das Potential nur um $^1/_3$ Proz. und ein Gehülfe konnte leicht durch ganz langsames Drehen der Elektrisiermaschine ein konstantes Potential halten.

Während der Rotation der Scheiben vor und nach jeder Beobachtungsreihe wurde der elektromagnetische Zähler nach

1) P. Czermak, Sitzungsber. d. k. Akad. d. Wissensch. zu Wien 97. Abt. 2. p. 307. 1888.

einer Sekundenuhr in Gang gesetzt und die Tourenzahl im Verlauf von einer Minute bestimmt. Da der Zähler jede 50 Touren angibt und der Apparat in einer Minute von 1500 bis 9000 Touren machte, so kann die Tourenzahlbestimmung bis auf ca. 1 Proz. genau gemacht werden.

Der Strom i ist von einem Akkumulator durch Widerstände abgezweigt und war von der Größe $4 . 10^{-4}$ Amp.

Es wurden immer doppelte Anschläge beim Kommutieren des Stromes oder der Ladung beobachtet und das Mittel aus zehn Beobachtungen genommen; aber ich habe mich mehrmals überzeugt, daß die Ausschläge bei + oder — Ladung und Entladung die Hälfte von den Ausschlägen beim Kommutieren waren (vgl. unten § 8 e).

Die Ausschläge a und b sind nicht direkt miteinander zu vergleichen, weil die Empfindlichkeit des Magnetometers, während die Scheiben rotierten oder in Ruhe waren, nicht immer dieselbe war; auch während des Versuches kann sich ja die Empfindlichkeit ändern, wenn durch irgend welche Ursachen große Nullpunktsänderungen eintreten. Deshalb wurde immer noch ein unbeweglicher Hülfsstrom benutzt und seine Wirkungen c auf das Magnetsystem einerseits mit der Wirkung b des Stromes i andererseits mit den magnetischen Wirkungen des Konvektionsstromes a verglichen.

Versuchsfehler.

The following pages of part I "BEWEGTE LEITER" of Eichenwald's paper are omitted; as in part I the ROWLAND CURRENT is discussed. Part II "BEWEGTE DIELEKTRIKA" of Eichenwald's paper is reproduced further here in toto, as in part II the displacement current is discussed (pages 421 - 433 are dedicated to the RÖNTGEN CURRENT and pages 434 - 441 are dedicated to the displacement current).

10. *Über die magnetischen Wirkungen bewegter Körper im elektrostatischen Felde; von A. Eichenwald.*

(Fortsetzung von p. 1.)

II. Bewegte Dielektrika.

25. Die bewegten Dielektrika habe ich ganz analog den bewegten Leitern untersucht, denn es besteht bekanntlich auch in den Erscheinungen selbst eine gewisse Analogie. Befindet sich ein Leiter oder ein Dielektrikum in einem elektrostatischen Felde, so wird in dem ersteren eine „wahre“ Ladung induziert, in dem letztgenannten eine „fingierte“. Alle diese Ladungen haften an der Materie und werden bei der Bewegung der Körper auch mit bewegt; es entsteht also im ersten Falle eine „wahre“, im zweiten eine „fingierte“ elektrische Konvektion, deren magnetische Wirkungen zu untersuchen sind.

Auch bei den Dielektrika wollen wir zwei wesentlich verschiedene Fälle unterscheiden: Erstens solche, wo die dielektrische Polarisation in einem beliebigen Punkte des Dielektrikums auch während der Bewegung unverändert bleibt (reine Konvektion vgl. § 2) und zweitens solche, wo die Polarisation in dem bewegten Dielektrikum sich mit der Zeit ändert. Beide Fälle habe ich experimentell untersucht, aber die größte Zahl der Versuche bezieht sich auf den ersten Fall.

26. Zunächst ist die Frage zu beantworten, ob die Dielektrika, wenn sie sich in einem konstanten elektrostatischen Felde bewegen, überhaupt irgend eine magnetische Wirkung ausüben können. Auf diese Frage geben die Versuche von Röntgen[1]) eine positive Antwort. Röntgen ließ eine horizontale Glas- oder Ebonitscheibe zwischen zwei geladenen Metallscheiben um eine vertikale Achse rotieren und beobachtete die Ablenkungen einer über der oberen Metallscheibe aufgehängten Magnetnadel, indem die Ladung kommutiert wurde. Der Sinn der so erhaltenen Ablenkungen war übereinstimmend mit der Annahme, daß ein im elektrostatischen Felde

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1) W. C. Röntgen, Wied. Ann. 35. p. 264. 1888; 40. p. 93. 1890.

bewegtes Dielektrikum in Bezug auf magnetische Wirkungen zwei Stromlamellen äquivalent ist, welche entgegengesetzt sind und zwar so, daß der im Sinne der Rotation gedachte Strom an der Oberfläche des Dielektrikums zu fingieren ist, welche der negativ geladenen Belegung am nächsten steht. Mit anderen Worten: Die fingierten Ströme fallen mit den bewegten fingierten Ladungen zusammen. Was aber die Größe der Ablenkungen anbetrifft, so erhielt Röntgen bei einer Potentialdifferenz zwischen den Belegungen von etwa 10000 Volts und 100 Umdrehungen in der Sekunde einen doppelten Ausschlag der Nadel beim Kommutieren von 2—3 mm bei 229 cm Skalenabstand. Wenn auch diese Wirkung sicher zu beobachten war, so war sie dennoch nicht sicher genug, um quantitative Messungen vornehmen zu können. Die Versuche von Röntgen sind meines Wissens noch von keinem wiederholt worden, obgleich ihre Bedeutung für die weitere Ausbildung der elektromagnetischen Theorie für bewegte Körper auf der Hand liegt. Nur in der ganz letzten Zeit, nämlich in einer soeben erschienenen Arbeit bestätigt H. Pender[1]) indirekt das Resultat von Röntgen, indem er zeigt, daß, wenn eine Hartgummischeibe in einem elektrischen Wechselfelde rotiert, in einem benachbarten Leiter Induktionsströme erzeugt werden. Diese Wechselströme werden bei H. Pender durch einen synchronen Kommutator gleichgerichtet und in einem empfindlichen Galvanometer beobachtet. Bei einer Potentialdifferenz von 7470 Volts und 57,8 Umdrehungen der Scheibe in der Sekunde erhielt H. Pender einen doppelten Ausschlag im Galvanometer von 4,5 mm. H. Pender hat diesen Ausschlag auch berechnet in der Annahme, daß die fingierten Ladungen an den beiden Seiten der Hartgummischeibe zwei entgegengesetzte Konvektionsströme bei der Rotation der Scheibe bilden, welche gleichzeitig mit dem elektrischen Felde ihre Richtung wechseln; der so berechnete Ausschlag ist 4,85 mm. Die Übereinstimmung mit dem beobachteten Ausschlage ist also eine gute, obgleich bei der Rechnung ein homogenes Feld vorausgesetzt ist, welche Bedingung bei dem Versuche (Scheibe ohne Schutzring) nicht erfüllt war. Wir können dennoch aus dieser Über-

1) H. Pender, Phil. Mag. (6) 5. p. 43. 1903.

einstimmung der beobachteten mit den berechneten Induktionswirkungen schließen, daß eine bewegte *fingierte* Ladung auch ein magnetisches Feld erzeugt, wie eine *wahre* elektrische Konvektion.

27. Bei meinen eigenen Untersuchungen habe ich ausschließlich statische elektrische Felder erzeugt und statische magnetische Felder mit dem Magnetometer direkt beobachtet. Zu den Versuchen diente derselbe Apparat wie früher (§ 3), nur sind die Anordnungen so getroffen, daß möglichst *homogene* elektrostatische Felder erzeugt werden.

Die hier beobachteten Wirkungen stellen meistens eine Differenz von den Wirkungen zweier Konvektionsströme vor; die Ablenkungen sind also notwendigerweise klein. Um solche kleine Ablenkungen sicher messen zu können, habe ich alle Maßregeln getroffen, um die möglichste Ruhe der Magnetnadel auch während der Rotation der Scheibe zu erzielen. Die Beobachtungen selbst habe ich nur nach Mitternacht ausführen können, wenn die Maschinen der hiesigen Zentrale ihre Arbeit beenden. Der Strom für den Dreiphasenmotor, welcher den Rotationsapparat in Bewegung setzte, wurde von einem Umformer geliefert, welcher seinerseits mit einem Akkumulatorenstrom gespeist wurde.

Um die Wirkungen der Konvektionsströme mit denen der galvanischen Ströme zu vergleichen, wurden zwei dünne, mit Stanniol beklebte Mikanitscheiben benutzt, welche dieselben Dimensionen wie die rotierenden Scheiben hatten und welche immer an die Stellen angebracht wurden, wo die Konvektionsströme während der Rotation, also an der Oberfläche der rotierenden Scheiben, zu erwarten waren. Die Belegung dieser Hülfsscheiben war durch feine Risse in einzelne Ringe (Fig. 8) von untereinander gleichem Flächeninhalte eingeteilt; diese Ringe entsprechen also gleichen Kapazitäten, gleichen Elektrizitätsmengen und gleichen Konvektionsströmen. Alle Ringe sind hintereinander geschaltet und werden von einem und demselben Strome i durchflossen. Ist C die Kapazität eines Ringes, V die Potentialdifferenz im Kondensator, n die Umdrehungszahl, a der doppelte Ausschlag

Fig. 8.

beim Kommutieren der Ladung während der Rotation, und b der doppelte Ausschlag beim Kommutieren des Stromes i, so ist

$$\frac{C V n}{a} = \frac{i}{b}.$$

Die Beobachtungen wurden in folgender Reihenfolge gemacht. Zunächst wurde die Scheibe Z an die Flächen, wo die Konvektionsströme zu erwarten waren, mit ein wenig Wachs sorgfältig angeklebt; sodann wurde der ganze Apparat zusammengestellt und die Wirkungen der Ströme b (es waren ja meistens zwei Ströme) mit den Wirkungen eines Hülfsstromes c verglichen. Nachdem dieses mehrmals geschehen ist, werden die Scheiben Z vorsichtig herausgenommen, ohne etwas an dem Rotationsapparate und an dem Magnetometer zu ändern. Beim Herausnehmen wurden natürlich die Stanniolringe (durch die Achse) zerrissen und mußten für jeden Versuch neu gemacht werden. Endlich wurde der Kondensator geladen, die Scheibe in Rotation versetzt und die Ausschläge a beim Kommutieren der Ladung mit den Ausschlägen c beim Kommutieren des Hülfsstromes verglichen.

Da wir hier homogene Felder benutzen, so fällt der in § 5 erwähnte Fehler wegen unregelmäßiger Verteilung der Ladung fort. Ebenso wird die Korrektion wegen ungleicher Verteilung der Konvektionsströme und der Leitungsströme in den einzelnen Ringen auch sehr klein, weil der äußere Ring nur 0,9 cm breit ist, die inneren Ringe aber erstens eine geringere magnetische Wirkung ausüben und zweitens immer größere Abstände von der Magnetnadel haben.

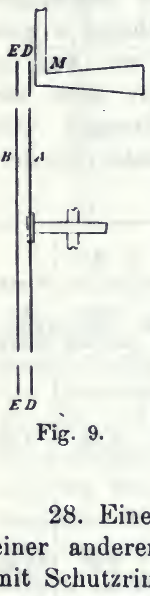

Fig. 9.

Die Versuche.

28. Eine rotierende Mikanitscheibe A (Fig. 9) bildet mit einer anderen unbeweglichen Scheibe B einen Kondensator mit Schutzringen D und E. Die Scheiben sind mit Stanniol beklebt, der Ring D ist aus Zink. B, E und D sind unbeweglich, A und D an Erde gelegt, B und E sind isoliert und können geladen werden. Während der Rotation der Scheibe A und beim Kommutieren der Ladung des Kondensators werden die Ablenkungen des Magnetometers M beob-

achtet. Zwischen A und B befindet sich entweder Luft oder eine Platte aus Hartgummi oder Glas. Die Platten werden an B fest angelegt, sodaß die Scheibe A frei rotieren kann.

Dieser Versuch ist also eine Wiederholung des in § 17 beschriebenen Versuches, aber dieses Mal mit Benutzung eines homogenen Feldes.

Bezeichnen wir mit d_0 den Abstand zwischen A und B und schieben wir eine dielektrische Platte von der Dielektrizitätskonstante ε und der Dicke d hinein, so vergrößert sich die Kapazität des Kondensators um

$$K = \frac{d_0}{\frac{d}{\varepsilon} + (d_0 - d_1)} \text{ mal.}$$

Bei mir war $d_0 = 1{,}25$ cm.

Für die Hartgummiplatte ist $d_1 = 0{,}95$ cm, $\varepsilon = 2{,}96$, $K = 2{,}0$.

„ „ Glasplatte „ $d_2 = 0{,}98$ „ $\varepsilon = 5{,}50$, $K = 2{,}8$.

In der Tab. V sind alle Beobachtungen und Rechnungen zusammengestellt. Für die beobachteten Ausschläge a gebe ich nur die Mittelwerte bei + und — Rotation an, weil der Unterschied zwischen diesen Größen immer sehr klein war. Der Wert a ist also das Mittel aus 20 Beobachtungen. Alle Ausschläge sind auf gleiche Empfindlichkeit der Nadel reduziert.

Tabelle V.

Dielektrikum	V	n	a beob.	a ber.	Diff.	$\frac{a}{V.n} 10^8$	Mittelwert von $\frac{a}{V.n} 10^8$	ε aus den Versuchen	ε direkt bestimmt
Luft	4000	± 78	± 4,2	± 4,0	+0,2	1,31	1,30	1,02	1,00
	6250	± 78	± 6,0	± 6,2	−0,2	1,24			
	8750	± 78	± 9,1	± 8,7	+0,4	1,33			
	6250	± 123	± 10,0	± 9,8	+0,2	1,30			
Hartgummi	4000	± 78	± 8,4	± 8,0	+0,4	2,70	2,59	2,97	2,96
	6250	± 78	± 12,2	± 12,4	−0,2	2,50			
	8750	± 78	± 17,5	± 17,4	+0,1	2,56			
	6250	± 123	± 20,0	± 19,6	+0,4	2,60			
Glas	4000	± 78	± 11,1	± 11,2	−0,1	3,56	3,62	5,16	5,50
	6250	± 78	± 18,0	± 17,4	+0,6	3,69			
	8750	± 78	± 24,7	± 24,4	+0,3	3,62			
	6250	± 123	± 27,8	± 27,5	+0,3	3,62			

Wie man sieht, stimmen die beobachteten und berechneten Werte der Ausschläge gut überein; auch die aus diesen Versuchen berechneten Dielektrizitätskonstanten sind mit den direkt bestimmten in genügender Übereinstimmung.

Ich muß noch bemerken, daß hier die Fehler in der Ausmessung der Größen d_0 einen bedeutenden Einfluß haben. Diese Abstände d_0 konnte ich aber nicht genauer als bis auf $^1/_2$ mm messen.

29. Die Belegung *A* (Fig. 10) ist jetzt eine Zinkplatte und unbeweglich aufgestellt. Eine Hartgummischeibe *A' B'* rotiert zwischen *A* und *B*. Aus demselben Hartgummi ist auch ein Schutzring *D' E'* hergestellt, sodaß das Feld als genügend homogen gelten kann. Jetzt ist $d_0 = 1{,}60$, $d_1 = 0{,}95$, $K = 1{,}72$.

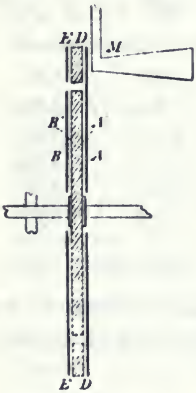

Fig. 10.

Bei der Rotation der Hartgummischeibe ohne Ladung erhält man Ablenkungen der Magnetnadel von 30 mm, welche aber von der Bewegungsrichtung unabhängig sind (vgl. § 8). Kommutiert man die Ladung während der Rotation der Hartgummischeibe *A' B'*, so erhält man Ablenkungen der Magnetnadel, welche mit dem Sinne der Rotation und der Ladung auch ihren Sinn wechseln; sie sind aber denjenigen Ablenkungen, welche man bei der Rotation der Scheibe *A* erhalten würde, entgegengesetzt. Das entspricht auch vollständig der Erwartung, denn ist die Scheibe *A* mit $+e$ geladen, so bedeckt sich die nächste Seite *A'* der Hartgummischeibe mit einer fingierten Ladung $-e$, die Seite *B'* wieder mit $+e$ und wir beobachten die Differenz der Wirkungen dieser zwei fingierten Konvektionsströme. Da der Strom $-A'$ näher zum Magnetometer gelegen ist und größere Wirkungen auf denselben ausübt, so ist die Differenz $-A' + B'$ negativ.

Nennen wir C die Kapazität des Kondensators mit Luft als Dielektrikum, so ist seine Kapazität mit der Hartgummischeibe KC. Die Ladung auf den Belegungen *A* und *B* ist KCV; die fingierten Ladungen an *A'* und *B'* sind $(K-1)CV$ und die fingierten Ströme $(K-1)CVn$.

Vor dem Versuche werden an die Flächen A' und B' die zwei oben beschriebenen Mikanitscheiben Z angelegt und ein bekannter galvanischer Strom durch die Stanniolspiralen geschickt und zwar bei A' und B' in entgegengesetzter Richtung. Beobachtet man dabei die Magnetometerablenkung b, so können die Ablenkungen, welche die beiden Konvektionsströme verursachen, berechnet werden. Folgende Tab. VI enthält die Resultate.

Tabelle VI.

Nr.	V	n	a beob.	a ber.	Diff.	$\frac{a}{V.n} \cdot 10^6$
1	8 000	± 68	∓2,0	∓1,8	+0,2	3,69
2	10 000	± 68	∓2,1	∓2,2	−0,1	3,09
3	12 500	± 68	∓3,1	∓2,7	+0,4	3,65
4	10 000	±104	∓3,2	∓3,3	−0,1	3,08
5	10 000	±118	∓3,9	∓3,8	+0,1	3,30
6	10 000	±130	∓4,4	∓4,2	+0,2	3,39
					Mittelwert:	3,37

Den Mittelwert von $a/Vn\ 10^6$ kann man benutzen, um die Größe K und die Dielektrizitätskonstante ε zu berechnen. Man erhält so

$$K = 1{,}75 \text{ statt } 1{,}73$$
$$\varepsilon = 3{,}02 \quad \text{„} \quad 2{,}96$$

Obgleich die beobachteten Ausschläge ziemlich klein sind, so kann man sie dennoch gut messen, weil die Nadel bei günstigen Versuchsbedingungen sich sehr ruhig verhält. Mit einer Glasscheibe habe ich diesen Versuch nicht gemacht, um die Zahl dieser schwierigen Versuche nicht zu vergrößern. Wir werden aber sehen (vgl. § 31), daß auch für Glas analoge Resultate zu erwarten sind.

Die Versuche zeigen also, daß *eine bewegte „fingierte“ Ladung in Bezug auf ihre magnetischen Wirkungen einer wahren elektrischen Konvektion oder auch einem gewöhnlichen Leitungsstrome von gleichem numerischen Betrage völlig äquivalent ist.*

30. Schon bei den ersten Versuchen von **Röntgen** mit bewegten Dielektrika haben die Herren **Rowland** und **Hutchinson** einen Einwand gemacht, daß man die von ihm be-

obachtete magnetische Wirkung nicht den fingierten, sondern den wahren Ladungen der dielektrischen Scheibe zuschreiben könnte. Solche Ladungen können in der Tat entweder durch die Leitfähigkeit der Luft oder des Dielektrikums entstehen. Im ersteren Falle würden aber die Flächen A' und A mit gleichnamiger Elektrizität geladen und alle Ausschläge der Magnetnadel müßten das entgegengesetzte Zeichen haben. Die Leitfähigkeit des Dielektrikums kann nur dann eine wahrnehmbare Ladung erzeugen, wenn die Ladungszeit mit der Relaxationszeit vergleichbar wäre. Nun ist aber Hartgummi ein vorzüglicher Isolator, dessen Relaxationszeit gewiß größer als 5 Sek. ist, welche Zeit bei unseren Versuchen von einem Kommutieren bis zum anderen gebraucht wurde.

H. Pender[1]) sieht in der von ihm gewählten Methode einen Vorteil in der Beziehung, daß dort kein konstantes Feld, sondern ein Wechselfeld benutzt wird und die Scheibe keine Zeit hat sich zu laden. Bei H. Pender wechselt das elektrische Feld 12—20 mal in der Sekunde. Aber schon Röntgen[2]) selbst hat eine Anordnung angegeben, in welcher die Polarisation im Dielektrikum 200 mal in einer Sekunde wechselt und dennoch blieb das Endresultat, d. h. die magnetische Wirkung ungeändert. Den oben erwähnten Einwand halte ich deshalb schon durch die Versuche von Röntgen selbst für gehoben.

Wollen wir aber dennoch die Möglichkeit voraussetzen, daß die Luft bei der schnellen Rotation der Scheibe sich verdünnt und ein wenig leitend wird, dann wird die magnetische Wirkung des fingierten Stromes zum Teil durch den wahren Konvektionsstrom vernichtet. Die beobachteten Ausschläge entsprechen einem Strome $i = (K - 1) C V n$, aber in Wirklichkeit könnte ein Strom $i_1 = K C V n$ bestehen. Die im folgenden § 31 beschriebenen Versuche[3]), in welchen kein Luftzwischenraum benutzt wird, schließen die hier vorausgesetzte Möglichkeit aus.

31. Lassen wir die beiden Belegungen eines Kondensators mit dem Dielektrikum zusammen rotieren, so müssen wir

1) H. Pender, l. c. p. 42.
2) W. C. Röntgen, Wied. Ann. 40. p. 97—100. 1890.
3) A. Eichenwald, Physik. Zeitschr. 4. p. 308. 1903.

folgendes erwarten. Auf jeder Belegung A und B wird ein Konvektionsstrom erzeugt von der Größe $i_1 = \varepsilon . C V n$ (Rowlandeffekt), wie es die Versuche in § 28 zeigen; auf jeder Seite des Dielektrikums A' und B' müssen wir einen Strom $-(\varepsilon - 1) C V n$ (Röntgeneffekt) fingieren (§ 29). Wir erhalten also eine Superposition beider Wirkungen und der äquivalente Strom an jeder Seite des Kondensators wird

$$i = \varepsilon . C V n - (\varepsilon - 1) C V n = C V n .$$

Wir können also die magnetischen Wirkungen bei diesen Versuchen so berechnen, als ob die Belegungen in Luft rotieren, denn die Dielektrizitätskonstante hat hier keinen Einfluß.

Bei der praktischen Ausführung dieser Versuche muß natürlich der Umstand berücksichtigt werden, daß die geladene, nicht zur Erde abgeleitete Belegung B des Kondensators sich von beiden Seiten ladet. Die Anordnung muß also folgendermaßen getroffen werden.

Eine Hartgummi- oder Glasscheibe von 25 cm Durchmesser ist von beiden Seiten A und B mit Stanniol beklebt und kann um eine horizontale Achse rotieren (Fig. 11). Zwischen den unbeweglichen Schutzringen D und E befindet sich dasselbe Dielektrikum, wie zwischen A und B. Das elektrische Feld zwischen A und B kann als genügend homogen gelten; der Zwischenraum zwischen dem Kondensator AB und seinem Schutzring ist 0,2 cm. CF ist eine unbewegliche Mikanitplatte mit Stanniolbelegung; der Abstand BC ist gleich 0,5 cm. Die Stanniolbelegung CF ist isoliert und wird immer auf dasselbe Potential geladen wie BE; zwischen B und C wird also kein elektrisches Feld erzeugt und B ladet sich nur von der zu A zugewandten Seite.

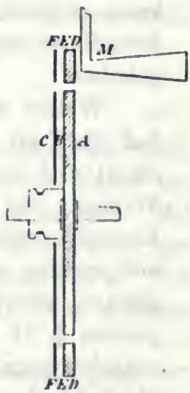

Fig. 11.

In der Tab. VII sind die Versuche mit einer Hartgummischeibe von 0,95 cm Dicke zusammengestellt; die Tab. VIII enthält die Resultate, welche mit einer Glasscheibe von 0,98 cm Dicke erhalten wurden.

Tabelle VII.

Dielektrikum: Hartgummi.

V	n	a beob.	a ber.	Diff.
7 500	± 65	+3,3 −3,4	±3,6	−0,3 −0,2
10 000	± 65	+4,9 −4,7	±4,7	+0,2 +0,0
7 500	± 95	+5,0 −4,9	±5,2	−0,2 −0,3
10 000	± 95	+7,1 −6,8	±6,9	+0,2 −0,1
7 500	±120	+6,3 −6,3	±6,6	−0,3 −0,3
10 000	±120	+9,0 −8,7	±8,7	+0,3 +0,0

Tabelle VIII.

Dielektrikum: Glas.

V	n	a beob.	a ber.	Diff.
7 500	±64	+4,5 −4,9	±4,8	−0,3 +0,1
10 000	±64	+6,2 −6,5	±6,4	−0,2 +0,1
7 500	±95	+7,6 −7,2	±7,1	+0,5 +0,1
10 000	±95	+9,6 +9,0	±9,5	+0,1 −0,5

Der Sinn und die Größe der beobachteten Ausschläge stimmen mit den berechneten gut überein.

Wir haben somit einen experimentell bewiesenen Satz: *Wird ein Kondensator bis zu einer gegebenen Potentialdifferenz* *geladen und mit dem Dielektrikum zusammen bewegt, so übt er eine magnetische Wirkung aus, welche aber vom Material des Dielektrikums unabhängig ist.*

Benutzen wir diesen Satz im Zusammenhange mit den im § 28 beschriebenen Versuchen, wo die Belegung allein in Rotation versetzt wurde, so können wir schließen, daß dem Röntgeneffekt wirklich ein äquivalenter Strom $i = (K - 1) C V n$ zukommt. Mit einer Glasscheibe habe ich den Röntgenversuch (§ 29) nicht gemacht, aber wegen der Übereinstimmung der Versuche in §§ 28 und 31 mit unseren Voraussetzungen müssen wir auch für Glas, wie für Hartgummi einen fingierten Konvektionsstrom von der Größe $(K - 1) C V n$ annehmen. Da bei dieser Versuchsanordnung kein Luftzwischenraum gebraucht wird, so sind die Versuche noch einwandsfreier, als die im § 29 beschriebenen und wir können noch sicherer schließen, daß nicht die Größe $K C V n$, sondern die Größe $(K - 1) C V n$ den fingierten Strömen beizulegen ist.

32. Noch von einem anderen Standpunkte aus kann unser letzter Versuch betrachtet werden. Wir können folgende drei Annahmen machen: Die magnetische Wirkung kann in irgend einem unbeweglichen Punkte des Raumes abhängen:

a) von der absoluten Bewegung der Ladung im Raume; dann ist der äquivalente Strom $i = \varepsilon . C . V . n$;

b) von der Bewegung der Ladung relativ zum Dielektrikum; bei unserem Versuche ist dann $i = 0$;

c) von der Bewegung der Ladung zu dem von der Ladung selbst erzeugten Felde; dann ist $i = C V n$. Denn die Ladung des Kondensators $\varepsilon . C . V$ muß aus zwei Teilen gedacht werden: der erste Teil $(\varepsilon - 1) C V$ erzeugt ein elektrisches Feld in der Materie und rotiert mit derselben, gibt also kein magnetisches Feld; der zweite Teil $C V$ rotiert im unbeweglichen Äther.

Würde also die erste Annahme a) richtig sein, wo $\varepsilon = 2,96$ ist, so müßten alle beobachteten Magnetometerausschläge fast dreimal größer als die berechneten sein, bei der zweiten Annahme b) würde man überhaupt keine Ausschläge erhalten und nur die dritte Annahme entspricht dem Versuche.

Es können also unsere Versuche nur durch eine solche Theorie erklärt werden, welche den Äther als ruhend annimmt oder zu solcher Anschauung führt; und zwar müssen wir den Äther als *ruhend nicht nur in der Umgebung bewegter Körper annehmen, sondern auch im Innern der bewegten Dielektrica selbst.*

33. Wir wollen jetzt die Ergebnisse unserer Versuche mit der elektromagnetischen Theorie für bewegte Körper vergleichen. Nach der Maxwell-Hertzschen Theorie können wir die hier beobachteten magnetischen Wirkungen dem Vorhandensein von Gleitflächen im elektrostatischen Felde zuschreiben, indem wir unter Gleitflächen die Flächen verstehen, an welchen sich die tangentialen Komponenten der Geschwindigkeiten unstetig ändern. An solchen Flächen müssen nach H. Hertz[1]) magnetische Kräfte entstehen von der Größe

$$M = A \, . \, \varepsilon \, . \, E \, . (v_1 - v_2),$$

wo E die normal zur Fläche genommene Polarisation und $v_1 - v_2$ die Geschwindigkeitsdifferenz oder die relative tangentiale Geschwindigkeit zweier sich berührender Körper bedeutet.

Wenden wir diese Gleichung an den Fall bewegter Leiter, so erhalten wir einen richtigen Wert der magnetischen Kraft: $M_1 = A \, . \, \varepsilon \, . \, E (v_1 - v_2)$; im Falle eines rotierenden Dielektrikums müssen wir schon an den Hertzschen Gleichungen eine Korrektion anbringen und $M_2 = A . (\varepsilon - 1) . E . (v_1 - v_2)$ schreiben; rotiert endlich der Kondensator mit seinen Belegungen zusammen, so haben wir im Sinne der Hertzschen Gleichungen überhaupt keine Gleitflächen, überall ist $v_1 - v_2 = 0$ und um M_3 in diesem Falle von Null verschieden zu erhalten, müssen wir den *Äther in den bewegten Dielektrika als ruhend annehmen.* Dann erhalten wir eine Gleitfläche zwischen jeder Belegung des Kondensators und dem angrenzenden ruhenden Äther im Dielektrikum. Die magnetische Wirkung wird dann übereinstimmend mit den Versuchen $M_3 = A \, . \, E . (v_1 - v_2)$.

Daraus sehen wir schon, daß die Maxwell-Hertzschen elektromagnetischen Gleichungen für bewegte Körper bei unseren Versuchen mit Dielektrika versagen. Was aber die Theorie von Lorentz anbetrifft, so liefert sie richtige Werte der magnetischen Wirkungen auch bei den bewegten Dielektrika, denn alle unsere Rechnungen sind eigentlich im Sinne der Lorentzschen Elektronentheorie gemacht worden. Aber

1) H. Hertz, Ausbreitung der elektrischen Kraft p. 274. 1892.

auch andere Theorien, welche den Versuch von **Fizeau** mit strömenden Wasser erklären, müssen auch richtige Werte für den Röntgeneffekt liefern, denn die oben an M_2 angebrachte Korrektion $\varepsilon - 1/\varepsilon$ ist ja nichts anderes, als der **Fresnelsche** Mitführungskoeffizient.

34. Ich will hier noch einen Kontrollversuch anführen. Es soll jetzt das Dielektrikum, nämlich Hartgummi mit der Belegung B rotieren, während A stillsteht (Fig. 12). Zwischen B und C ist kein elektrisches Feld vorhanden. Dann müssen wir bei der Berechnung bei B einen Strom CVn und bei A' einen Strom $(K-1)CVn$ fingieren. Beide Ströme sind gleichgerichtet und die magnetischen Wirkungen addieren sich.

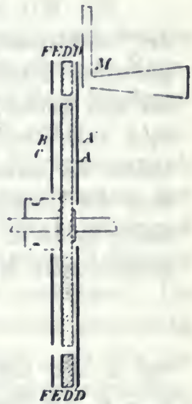

Fig. 12.

Tabelle IX.

V	n	a beob.	a ber.	Diff.	$\frac{a}{V.n}\,10^6$
3 750	± 72	∓2,3	∓2,2	+0,1	0,85
5 000	± 72	∓2,9	∓3,0	−0,1	0,81
6 250	± 72	∓3,5	∓3,7	−0,2	0,78
7 500	± 72	∓4,7	∓4,4	+0,3	0,87
10 000	± 72	∓6,1	∓5,9	+0,2	0,85
10 000	±116	∓9,3	∓9,5	−0,2	0,80

Mittelwert: 0,827
Berechnet: 0,821

Auch in diesem Fall stimmen unsere Rechnungen mit den Beobachtungen.

35. Bis jetzt sind bei der Bewegung der Dielektrika nur solche Fälle behandelt worden, wo das Feld während der Rotation unverändert blieb. Benutzt man Dielektrika, welche keine Rotationskörper sind und teilt man noch die Belegungen in einzelne isolierte Sektoren, so erhält man in denselben Wechselströme, welche man, wie in § 19 und § 20, mit dem Telephon nachweisen kann.

Läßt man eine biskuitartige Hartgummiplatte über einer gut leitenden Glasplatte im elektrostatischen Felde Torsionsschwingungen ausführen, so werden diese Schwingungen durch die dabei entstehenden Konduktionsströme in der Glasplatte gedämpft. Nimmt man eine volle Hartgummischeibe, so erhält man keine Dämpfung ganz analog dem § 22. Alle diese Versuche sind leicht zu machen.

36. Endlich können noch bei der Bewegung des Dielektrikums im elektrostatischen Felde Verschiebungsströme entstehen und es ist die Frage zu beantworten, ob solche Ströme auch ein magnetisches Feld erzeugen. Diese wichtige Frage ist bekanntlich indirekt durch die Hertzschen Versuche im positiven Sinne schon beantwortet; aber es ist dennoch wünschenswert, einen direkten Beweis dafür zu liefern. Der einzige direkte Versuch in dieser Richtung ist von Röntgen[1]) gemacht worden; die Versuche von S. P. Thomson[2]) (mit Telephon), von Nikolaieve[3]) (Induktion) sind nicht einwandsfrei und indirekt; endlich sind noch die Versuche von R. Blondlot[4]) und J. Whitehead[5]) zu erwähnen, obgleich die letztgenannten Verfasser aus ihren Versuchen den Schluß ziehen, daß eine magnetische Wirkung des Verschiebungsstromes überhaupt nicht vorhanden wäre. Aber sogar die mit Erfolg angestellten Versuche können schon deshalb keine befriedigende Antwort geben, weil sie alle nur einen qualitativen Charakter haben. Der einzige Versuch, der hier in Betracht genommen werden kann, ist der von Röntgen und da ich im Prinzip dieselbe Methode benutzt habe, so will ich kurz den Röntgenschen Versuch beschreiben.

Eine horizontale Ebonitscheibe von 16 cm Durchmesser und 0,5 cm Dicke rotiert um eine vertikale Achse zwischen zwei unbeweglichen ringförmigen Stanniolbelegungen. Die untere Belegung ist in zwei voneinander isolierte Halbringe eingeteilt, welche immer entgegengesetzt geladen werden; die obere Be-

1) W. C. Röntgen, Sitzungsber. d. k. Akad. d. Wissensch. zu Berlin p. 195. 1885; Rep. d. Phys. 21. p. 521. 1885.

2) S. P. Thomson, Proc. Roy. Soc. 45. p. 392. 1889.

3) W. de Nikolaieve, Journ. de Phys. 4. p. 245. 1895.

4) R. Blondlot, Journ. de Phys. 1. p. 8. 1902.

5) J. B. Whitehead jr., Physik. Zeitschr. 4. p. 229. 1903.

legung ist dauernd zur Erde abgeleitet. Bei jeder Umdrehung der Scheibe wechselt in derselben die Polarisation zweimal ihr Zeichen und es entstehen an der Trennungslinie der Halbringe zwei vertikale Verschiebungsströme, welche entgegengesetzt gerichtet sind. Dicht über der oberen Belegung ist eine empfindliche Magnetnadel aufgehängt; ihre Mitte befindet sich in der Verlängerung der Drehungsachse, und ihre Richtung ist parallel mit der Trennungslinie der Halbringe. Beide Verschiebungsströme müssen auf die Nadel in gleichem Sinne wirken. Beim Kommutieren der Ladung während der Rotation der Scheibe erhielt Röntgen im günstigsten Falle einen doppelten Ausschlag von 1,5 mm bei 3 m Skalenabstand und erst nach einer großen Übung „konnte Röntgen bei seinen letzten Versuchen die Ablenkungsrichtung fast ausnahmslos richtig angeben“. [1]) Aus dieser Beschreibung ist zu ersehen, daß es wünschenswert ist erstens eine größere Sicherheit in der Beobachtung zu erzielen und zweitens quantitative Resultate zu erhalten, welche einen Vergleich mit der Theorie erlauben. Außerdem ist noch zu beweisen, daß die beobachteten Ablenkungen von der magnetischen Wirkung der Verschiebungsströme und nicht der Konvektionsströme (§ 29) herrühren; diese letzte Wirkung wechselt nämlich auch ihr Zeichen mit dem Sinne der Ladung und der Rotation.

37. Wie gesagt, habe ich im Prinzip dieselbe Methode benutzt wie Röntgen, die Anordnung war aber eine andere. Eine vertikale Hartgummischeibe $A'B'$ (Fig. 13) kann um eine horizontale Achse rotieren. Die Scheibe ist am Rande 1,25 cm dick, in der Mitte aber nur etwa 0,5 cm, sodaß sich am Rande ein 1,5 cm breiter Hartgummiring bildet. Parallel mit der Scheibe sind zwei unbewegliche Mikanitplatten mit ringförmigen Stanniolbelegungen aufgestellt. Der Abstand zwischen A und B ist 1,50 cm, sodaß $AA' = BB' = 0{,}125$ cm ist. Die Belegungen sind in Halbringe geteilt und lassen oben und unten je einen Zwischenraum von 1 cm frei. Um den früher benutzten Rotationsapparat nicht umzubauen, ließ ich die Scheiben wie früher im magnetischen Meridian rotieren, den über dem oberen

1) W. C. Röntgen, Sitzungsber. d. k. Akad. d. Wissensch. z. Berlin p. 197. 1885.

Rande der Scheibe aufgehängten Magnetometer *M* aber um 90° gedreht. Die Magnetnadel mußte jetzt in der Ostwestrichtung stehen und das konnte leicht durch den Astasierungsmagneten erzielt werden. Wird die Scheibe in Rotation versetzt und alle Halbringe paarweise entgegengesetzt geladen, so entstehen bei *a c* und *b d* (Figg. 13 und 15) Verschiebungsströme, welche die Magnetnadel ablenken. Betrachten wir den ganzen Apparat von oben (Fig. 15) und ist der nördliche Halbring *An* mit $+e$, der nördliche Halbring *Bn* mit $-e$ und die südlichen Halbringe entgegengesetzt den nördlichen geladen, so muß bei der Bewegung des Dielektrikums in der Pfeilrichtung (Fig. 15) ein Verschiebungsstrom von *A* nach *B* entstehen. Die Versuche zeigen, daß die Nadel *n s* wirklich der Richtung dieser Verschiebungsströme entsprechend abgelenkt wird. Die Ablenkungen wechseln ihr Zeichen mit dem Sinne der Ladung und der Rotation.

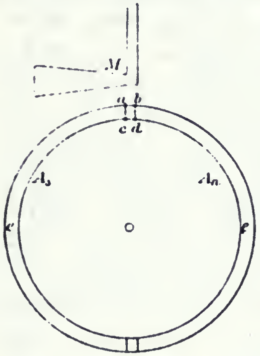

Fig. 13.

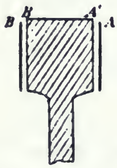

Fig. 14.

Wird der ganze Ring *A* mit gleichnamiger Elektrizität geladen, die Halbringe *Bs* und *Bn* aber mit ungleichnamiger, so reduzieren sich die Ablenkungen der Magnetnadel auf die Hälfte. Werden endlich die Halbringe so leitend verbunden, daß die Ringe *A* und *B* entgegengesetzt, aber ihre Hälften gleichnamig geladen werden, so erhält man keine Ausschläge der Nadel. Im letzteren Falle entsteht nämlich bei der Bewegung keine Änderung der dielektrischen Polarisation, wohl aber ein Konvektionsstrom (§ 28); bei der hier gewählten symmetrischen Lage der Nadel können die Konvektionsströme, welche senkrecht zu der Magnetnadel verlaufen, auf dieselbe keine Wirkung ausüben, und der Versuch bestätigt auch dieses vollkommen.

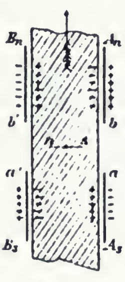

Fig. 15.

38. Um die magnetischen Wirkungen des Verschiebungsstromes mit den Wirkungen eines galvanischen Stromes zu

vergleichen, werden vor dem Versuche an den Hartgummiring vier Halbringe aus Zink mit ein wenig Wachs angeklebt, ganz entsprechend den Stanniolbelegungen des Kondensators. (In den Figg. 13, 14 und 15 müssen jetzt die Belegungen an die Hartgummischeibe fest angelegt gedacht werden, dann stellen sie die Zinkhalbringe vor.) An den Punkten a, b, c und d sind an die Halbringe feine Drähtchen angelötet, welche durch die Hartgummischeibe hindurch gehen und die auf den entgegengesetzten Seiten der Scheibe angeklebten Zinkhalbringe miteinander leitend verbinden, und zwar in der Weise, daß a mit a', b mit b' (Fig. 15) etc. verbunden werden. Schickt man jetzt einen bekannten galvanischen Strom in der Richtung $A_s . a . a' . B_s$ einerseits und einen zweiten Strom in der Richtung $B_n . b' . b . A_n$, so fallen die Richtungen dieser Ströme mit denen der fingierten Ströme zusammen. Die Teile dieser Stromkreise, welche mit $a a'$, $b b'$ etc. bezeichnet sind, sollen den Verschiebungsströmen, welche bei der Bewegung im Dielektrikum entstehen, äquivalent sein. In Wirklichkeit aber kommt der Verschiebungsstrom nicht in den einzelnen Stromfaden $a a'$ etc. zu stande, sondern in den zwei Flächen $a c a'$ und $b d b'$; wir machen also hier denselben Fehler wie in § 5, welcher aber, wie eine annähernde Rechnung zeigt, bei dem großen Abstande der Magnetnadel (1,5 cm) von $a a'$ und $b b'$ kleiner als die Beobachtungsfehler (etwa 5 Proz.) ausfällt.

Die Versuche wurden in folgender Reihenfolge angestellt. Zunächst werden die Zinkhalbringe an die Hartgummischeibe angeklebt, zusammengelötet und der ganze Apparat zusammengestellt. Sodann dreht man die Scheibe so, daß der Punkt e (Fig. 13) an dem Magnetometer zu stehen kommt und sucht eine solche Stellung der Nadel $n s$ auf, bei welcher die Wirkung des in den Halbringen $A_n . b . b' . B_n$ zirkulierenden galvanischen Stromes ein Minimum wird. (Bei einer idealsymmetrischen Aufstellung müßte das Minimum gleich Null sein, weil die Ströme senkrecht zu der Nadel verlaufen.) Jetzt dreht man die Scheibe zurück, bis der Zwischenraum in den Zinkhalbringen mit dem Zwischenraum in den Stanniolbelegungen zusammenfällt und beobachtet die Ausschläge b der Nadel beim Kommutieren des Stromes i in den Zinkhalbringen; die Nadel muß dabei dieselbe Nulllage haben, welche in dem vorhergegangenen Versuche ausgesucht wurde; das kann leicht durch einen kleinen Richtmagneten vom Beobachtungsplatze aus erzielt werden. Dieselbe Nulllage der Nadel muß auch bei den Versuchen mit den Verschiebungsströmen beibehalten werden.

Bei mir war $i = 4 . 10^{-5}$ Amp.; $b = 49{,}6$ mm bei 2 m Skalenabstand. Rückt der Punkt e an das Magnetometer, so erhält man Ausschläge der Magnetnadel, die kleiner als 1 mm sind und nur bei $i = 20 . 10^{-5}$ Amp. erhielt ich einen doppelten Ausschlag von 4 mm. Der Fehler ist also kleiner als 2 Proz. und kann vernachlässigt werden.

Die Größe des Verschiebungsstromes kann man folgendermaßen berechnen. Ist ε die Dielektrizitätskonstante und E die elektrische Kraft, so ist bekanntlich der Verschiebungsstrom

$$(i) = \frac{\varepsilon}{4\pi} \frac{d E \omega}{d t}.$$

Bei uns bleibt aber E unverändert mit der Zeit und außerdem wollen wir annehmen, daß sich bei der Bewegung *nur in der Materie* ein Verschiebungsstrom bildet, der Äther aber in Ruhe bleibt; dann ist

$$(i) = \frac{(\varepsilon - 1)}{4\pi} . E . \frac{d\omega}{d t} = \frac{(\varepsilon - 1) E}{4\pi} S n,$$

wo S die ganze Fläche eines Ringes A und n die Umdrehungszahl in der Sekunde bedeutet. Es ist aber bei homogenem Felde

$$S = 4\pi C d \quad \text{und} \quad E = \frac{V}{d},$$

also

$$(i) = (\varepsilon - 1) C V n.$$

Endlich muß man noch berücksichtigen, daß nicht der ganze Zwischenraum mit dem Dielektrikum ausgefüllt ist und die Größe ε durch die Größe K (§ 28) ersetzt werden muß.

Beobachtet man während der Rotation der Scheibe beim Kommutieren der Ladung einen Ausschlag a, so muß wie früher sein

$$\frac{(K - 1) C V n}{a} = \frac{i}{b}.$$

Die Rechnung haben wir für ein homogenes Feld durchgeführt. Bei einem unhomogenen Felde, welches wir notwendigerweise bei unseren Versuchen benutzen müssen, bedeutet $(K - 1)C$ die Kapazitätsvergrößerung, welche bei einem Luftkondensator AB eintritt, wenn in denselben eine Hartgummiplatte $A'B'$ eingeschoben wird. Ich habe $(K - 1)C$ direkt bestimmt und erhielt $(K - 1)C = 0{,}9 \cdot 10^{-11}$ Farad. Auf diese Weise habe ich die Ausschläge a der Magnetnadel berechnet und sie mit den beobachteten verglichen, wie es in der Tab. X angegeben ist.

Tabelle X.

V	n	a beob.	a ber.	Diff.
3000	± 65	+2,0 −2,0	±2,2	−0,2 −0,2
6250	± 65	+4,9 −4,7	±4,5	+0,4 +0,2
3000	±110	+3,0 +3,8	±3,7	−0.7 +0,1
6250	±110	+8,0 −7,9	±7,7	+0.3 +0.2
3000	±134	+4,4 +4,2	±4,5	−0.1 −0.3
6250	±134	+9,8 −9,6	±9,4	+0.4 +0,2

Obgleich die Übereinstimmung der Beobachtung und Rechnung auch hier eine gute ist, so muß ich dennoch bemerken, daß ich diesen Versuchen nur eine Genauigkeit bis etwa 10 Proz. beilegen kann. Wahrscheinlich kompensieren sich teilweise die verschiedenen hier vorkommenden Fehler. Außerdem wanderte der Nullpunkt der Nadel während der Zeit einer Ablesung um etwa 2 mm, was bei der Kleinheit der beobachteten Ausschläge schon einen bemerkbaren Einfluß auf den Mittelwert haben kann. Ich habe immer 10 Ablesungen nacheinander gemacht und dann durch einen Richtmagneten die Nadel auf die frühere Stelle gebracht. Ein Hülfsstrom c diente auch hier, wie bei allen früheren Beobachtungen, zur Kontrolle der Empfindlichkeit der Magnetnadel.

Durch diese Versuche ist also direkt gezeigt worden, daß auch *der Verschiebungsstrom ein magnetisches Feld erzeugt und zwar von der Größe, welche von der Theorie verlangt wird.*

39. Diese Versuche zeigen außerdem, daß der Verschiebungsstrom, welcher bei der Bewegung des Dielektrikums in einem unhomogenen elektrischen Felde entsteht, nicht der Änderung der gesamten Polarisation des Dielektrikums mit der Zeit, sondern nur der zeitlichen Änderung der Polarisation der bewegten Materie gleich ist. Wir haben nämlich unsere Versuche nach der Formel $(K-1) C V n$ und nicht nach der Formel $K C V n$ berechnet (vgl. § 33). Dieser Verschiebungsstrom ist ja nichts anderes, als die Fortsetzung des Konvektionsstromes, welchen wir an den beiden Seiten der bewegten dielektrischen Scheibe fingieren müssen. In der Tat zeigt auch die auf p. 438 durchgeführte Rechnung, daß beide Ströme dieselbe Größe haben. Der ganze Stromkreis, Konvektionsstrom + Verschiebungsstrom erscheint hier ganz in derselben Weise geschlossen, wie unser galvanischer Strom i, welchen wir vor dem Versuche durch die Zinkhalbringe geschickt haben.

Vergleichen wir diesen Versuch mit dem Versuche in § 21 [1]), wo die Konduktionsströme, welche durch Bewegung des Leiters in einem unhomogenen Felde entstehen, beobachtet wurden, so finden wir, daß beide Versuche ganz analog erscheinen. In beiden Fällen entstehen in den bewegten Körpern Wechselströme, welche bei dem Magnetometer, ebenso wie bei jedem unbeweglichen Punkte immer mit derselben Phase vorbeigehen und so im äußeren Raume ein statisches magnetisches Feld erzeugen. Auch im Falle eines bewegten Leiters wird der Konvektionsstrom K durch zwei Konduktionsströme G zu einem geschlossenen Stromkreise ergänzt.

Bei reiner elektrischer Konvektion ist der Konvektionsstrom in sich selbst geschlossen.

Wir schließen also, daß alle von uns beobachteten Ströme (Konvektions-, Leitungs- und Verschiebungsströme) stets *geschlossene* Stromkreise bilden.

1) A. Eichenwald, Ann. d. Phys. 11. p. 26. 1903.

Resultate.

In der vorliegenden Arbeit sind die magnetischen Wirkungen bewegter Körper im elektrostatischen Felde unter möglichst variierten Versuchsbedingungen *quantitativ* untersucht worden. Es wurden Geschwindigkeiten bis zu etwa 150 m in der Sekunde und Feldstärken bis zu etwa 30 C.G.S. gebraucht. Die Messungen können mit Fehlern in maximo bis zu etwa 10 Proz. behaftet sein.

Unter allen diesen Beschränkungen lassen sich die Ergebnisse unserer Versuche folgendermaßen kurz zusammenstellen.

1. Bei der Bewegung der Körper im elektrostatischen Felde entstehen im allgemeinen Konvektions-, Konduktions- und Verschiebungsströme; alle diese Ströme sind in Bezug auf magnetische Wirkungen den Wirkungen eines galvanischen Stromes von gleichem numerischen Betrage völlig äquivalent.

2. Im Falle reiner elektrischer Konvektion sind die Bewegungen und die magnetischen Wirkungen der bewegten Ladungen unabhängig voneinander. Die Ladungen haften an der Materie.

3. Alle von uns beobachteten Ströme bilden stets geschlossene Stromkreise.

4. Die Versuche sind mit der Annahme eines überall auch in den bewegten Dielektrika ruhenden Äthers im Einklange.

Zum Schluß will ich noch bemerken, daß ganz analoge Gesetze auch für die Bewegung der Körper im magnetischen Felde gelten müssen; nur haben wir keinen „wahren" Magnetismus.

Moskau, Ingenieur-Hochschule, Februar 1903.

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HANDBUCH DER EXPERIMENTALPHYSIK

HERAUSGEGEBEN VON

W. WIEN † UND F. HARMS
MÜNCHEN WÜRZBURG

UNTER MITARBEIT VON

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MÜNCHEN

BAND 11
1. TEIL

ELEKTRODYNAMIK

VON

GUSTAV MIE
O. PROF. AN DER UNIVERSITÄT FREIBURG I. BR.

1932
AKADEMISCHE VERLAGSGESELLSCHAFT M. B. H.
LEIPZIG

Viertes Kapitel.

Verschiebungsströme.

§ 1. Magnetische Felder sind Ursache der Änderungen des elektrischen Zustandes im Äther.

Wenn wir als die Grundgleichung der magnetischen Erregung annehmen: $\mathfrak{rot}\ \mathfrak{H} = \mathfrak{i}$, so müssen wir schließen, daß der Vektor $\mathfrak{i}$ weder Quellpunkte noch Sinkstellen haben könne, denn weil allgemein $\operatorname{div}\mathfrak{rot} = 0$, so folgt aus der Gleichung $\operatorname{div}\mathfrak{i} = 0$. Diese Folgerung erregt auf den ersten Blick Bedenken, denn wenn man irgendeinen Körper elektrisch aufladen will, so muß man einen elektrischen Strom zuleiten, der bei positiver Aufladung in dem Körper endigt, bei negativer aus ihm entspringt. In früheren Zeiten hat man sich denn auch vielfach Gedanken darüber gemacht, wie das magnetische Feld eines „ungeschlossenen Stromes" aussehen könne, und hatte nach dem für ein einzelnes Stromelement geltenden „Elementargesetz" gesucht. Es war die geniale Tat Maxwells, den Begriff des Stromes so zu erweitern, daß sich immer geschlossene Stromlinien ergeben müssen, so daß nun das Gesetz $\mathfrak{rot}\ \mathfrak{H} = \mathfrak{i}$ wirklich das allgemein gültige Grundgesetz der magnetischen Erregung darstellt. Wenn wir mit ϱ die räumliche Dichte der elektrischen Ladung bezeichnen, so gilt für die Erregung $\mathfrak{D}$ des elektrischen Feldes die Gleichung $\operatorname{div}\mathfrak{D} = \varrho$. Andererseits gilt für den

Leitungsstrom i, der einem Körper eine Ladung zuführt, die „Kontinuitätsgleichung“: $\operatorname{div} \mathfrak{i} = -\partial\varrho/\partial t$. Daraus folgt:

$$\operatorname{div} \mathfrak{i} = -\operatorname{div} \frac{\partial \mathfrak{D}}{\partial t}, \qquad \operatorname{div} \left(\mathfrak{i} + \frac{\partial \mathfrak{D}}{\partial t}\right) = 0.$$

Man kann also den Vektor $\partial\mathfrak{D}/\partial t$ auffassen als Fortsetzung des Stromes i in das umgebende Dielektrikum hinein um den Körper herum, welchem die Ladung zugeführt wird, in welchem also i selber endigt. Die Größe $\partial\mathfrak{D}/\partial t$ wird nach Maxwell „der elektrische Verschiebungsstrom im Dielektrikum“ genannt. Ein sehr einfaches Beispiel liefert ein Plattenkondensator, der durch einen Strom J Amp aufgeladen wird. Die Zunahme der Ladung $\pm e$ der beiden Platten berechnet sich als: $de/dt = J$. Ist die Flächengröße der Platten f cm^2, so ist die Flächendichte der Ladung $\sigma = e/f$, dies ist zugleich der Wert der Erregung D des homogenen elektrischen Feldes in dem Dielektrikum des Kondensators:

$$\frac{e}{f} = D \frac{\text{Coulomb}}{\text{cm}^2}.$$

Der Verschiebungsstrom beträgt an jeder Stelle des homogenen Feldes $\partial D/\partial t$ Ampere/cm^2, der gesamte Wert des Verschiebungsstroms über den ganzen Querschnitt f des Dielektrikums ist also:

$$f \cdot \frac{\partial D}{\partial t} = \frac{de}{dt} = J.$$

Man sieht, daß der Verschiebungsstrom im Dielektrikum als Fortsetzung des zu der Platte führenden Leitungsstroms diesen zu einem Strom ohne Quellen und Sinkstellen ergänzt. Danach ist nun das erste Maxwellsche Grundgesetz der Elektrodynamik allgemein so zu formulieren:

$$\operatorname{rot} \mathfrak{H} = \mathfrak{i} + \frac{\partial \mathfrak{D}}{\partial t},$$

wo i den Leitungsstrom und Konvektionsstrom und $\partial\mathfrak{D}/\partial t$ den Verschiebungsstrom darstellt. Wird i in Amp/cm^2 gemessen, so muß $\mathfrak{D}$ in Coulomb/cm^2 und $\mathfrak{H}$ in Amp/cm angegeben werden.

Diese Gleichung gewinnt ein ganz besonderes Interesse, wenn wir ein Gebiet in einem vollkommenen Isolator ins Auge fassen, wo $\mathfrak{i} = 0$. In diesem Gebiet gilt $\operatorname{rot} \mathfrak{H} = \partial\mathfrak{D}/\partial t$, und diese Gleichung sagt aus, daß eine Änderung des durch den Vektor $\mathfrak{D}$ charakterisierten elektrischen Zustandes an irgendeiner Stelle im Raum nur hervorgebracht werden kann durch einen im magnetischen Feld $\mathfrak{H}$ zutage tretenden Vorgang im Äther, welcher die Bedingung zu erfüllen hat: $\mathrm{rot}\,\mathfrak{H} \neq 0$, damit eine Änderung von $\mathfrak{D}$ eintritt.

Man kann sich eine gewisse Anschauung von diesen an sich wenig anschaulichen Dingen verschaffen, wenn man sie mit analogen Vorgängen in der greifbaren Materie vergleicht. Ein elastischer Körper kann auf keine andere Weise eine Änderung seines elastischen Zustandes erfahren, als dadurch, daß kleine Bewegungen in ihm auftreten, durch welche seine Teilchen Deformationen bekommen. Denken wir etwa an den einfachen Fall eines geraden zylindrischen Drahtes, der elastisch gespannt werden soll. Seine Teilchen müssen dazu alle eine kleine Bewegung $\mathfrak{v}_x$ in der Längsrichtung x des Drahtes erfahren, und zwar muß diese Bewegung, damit der Draht eine Längsdeformation bekommt, die Bedingung erfüllen $\partial \mathfrak{v}_x / \partial x \neq 0$. Wenn wir die spezifische Dehnung der Teilchen des Drahtes, welche seinen elastischen Zustand charakterisiert, mit a_{xx} bezeichnen, so ist:

$$\frac{\partial \mathfrak{v}_x}{\partial x} = \frac{\partial a_{xx}}{\partial t}.$$

Diese Gleichung ist das genaue Analogon zu der ersten MAXWELLschen Gleichung. Der Deformation a_{xx} entspricht die elektrische Erregung $\mathfrak{D}$, welche MAXWELL, um ihre Verwandtschaft mit einer Deformationsgröße anzudeuten, die „elektrische Verschiebung" in dem Dielektrikum nennt, der Bewegung $\mathfrak{v}_x$ entspricht die magnetische Erregung $\mathfrak{H}$, welche ja durch eine elektrische Bewegung, einen elektrischen Strom gemessen wird. Genau so, wie die Deformation a_{xx} verbunden ist mit einer elastischen Spannung X_x, die mit ihr in der Beziehung steht: $a_{xx} = \alpha \cdot X_x$, wo α die „elastische Nachgiebigkeit" oder den „Elastizitätskoeffizienten" der Dehnung, eine Materialkonstante, bedeutet, so ist auch die elektrische Erregung $\mathfrak{D}$ verbunden mit einer elektrischen Spannung $\mathfrak{E}$, welche zu ihr in der Beziehung steht $\mathfrak{D} = \epsilon \cdot \mathfrak{E}$, wo ϵ die „elektrische Nachgiebigkeit" oder die „Dielektrizitätskonstante" des dielektrischen Materials bedeutet.

Man kann sich insbesondere die Beziehung zwischen dem Rotor $\mathfrak{H}$ und dem polaren Vektor $\mathfrak{D}$ folgendermaßen veranschaulichen. Auf einer kreisförmig geschlossenen Achse mögen viele kleine kugelförmige Rädchen rotieren, alle mit gleicher Rotationsgeschwindigkeit, so daß die in einem einheitlichen Sinn durchlaufene kreisförmige Achse überall die Richtung des Rotors darstellt. Dann bewegt sich der Umfang all der Rädchen auf der inneren Seite des Kreises in einer und derselben Richtung, und wenn wir etwa einen zylindrischen Stab in den Ring hineinstecken, dessen Durchmesser so groß ist, daß er gerade überall die Rädchen berührt, so wird dieser Stab, indem die Rädchen ihn packen, nach einer Seite vorgeschoben. Der Vektor der Verschiebung dieses Stabes ist das Analogon zu $\mathfrak{D}$, oder genauer zu dem Flächenintegral von $\mathfrak{D}$ über die von dem Ring umschlossene Kreisfläche, und die Rotationsgeschwindigkeit der Rädchen ist das Analogon zu $\mathfrak{H}$. Wenn es erlaubt ist, von diesen feinen Äthervorgängen einmal mit etwas groben Worten zu reden, so möchte man sagen: Das eine geschlossene Linie bildende magnetische Feld $\mathfrak{H}$ quetscht gewissermaßen den Äther durch die von der Linie umschlossene Fläche hindurch, so daß eine im Lauf der Zeit anwachsende Änderung der ganzen elektrischen Verschiebung auf dieser Fläche eintritt. Wie sich diese Änderung über die Fläche verteilt, dafür ist der Wert von $\mathfrak{rot}\,\mathfrak{H}$ in den einzelnen Flächenelementen maßgebend: Wo $\mathfrak{rot}\,\mathfrak{H} = 0$, tritt überhaupt keine Änderung ein, und wo $\mathfrak{rot}\,\mathfrak{H} \neq 0$, da ist die Größe $\mathfrak{rot}\,\mathfrak{H}$ selbst das Maß der Änderung. Da das Linienintegral des Vektors $\mathfrak{H}$ auf der Umgrenzungslinie gleich dem Flächenintegral der Größe $\mathfrak{rot}\,\mathfrak{H}$ über die ganze umschlossene Fläche ist, so kommt immer der richtige Gesamtwert für die Änderung der elektrischen Verschiebung durch die ganze Fläche heraus.

Erst auf diese Weise bekommen wir das richtige Verständnis auch für den Zusammenhang des einen Stromleiter umschlingenden magnetischen Feldes mit dem Vorgang des elektrischen Stromes im Leiter selbst. Das Wesen des Stromes besteht darin, daß die in dem elektrischen Feld vorwärts bewegten elektrisch geladenen Teilchen, Ionen oder Elektronen, das Feld auf ihrem Wege gewissermaßen weglöschen, denn es ist klar, daß die Ionen, indem sie die Energie des elektrischen Feldes zu der Unterhaltung ihrer Bewegung aufbrauchen, gleichzeitig das Feld zerstören müssen. Bei einem stationären Strom wird nun aber das elektrische Feld immer sogleich wiederhergestellt, denn es bleibt ja konstant, und diese fortwährende Wiederherstellung des durch die wandernden Ionen zerstörten elektrischen Feldes, das ist eben die Wirkung des den Leiter umschlingenden magnetischen Feldes. Dieses Feld wirkt in dem Sinne, daß eine fortwährende Steigerung des elektrischen Feldes im Innern des Drahtes eintreten müßte: $\mathfrak{rot}\,\mathfrak{H} = \partial\mathfrak{D}/\partial t$, wenn nicht diese Steigerung durch die zerstörende Wirkung der Ionenwanderung immer sofort wieder rückgängig gemacht würde. An die Stelle der nicht zustande kommenden Feldsteigerung $\partial\mathfrak{D}/\partial t$ tritt deswegen hier der ihr äquivalente feldzerstörende Vorgang des Leitungsstromes: $\mathfrak{rot}\,\mathfrak{H} = \mathfrak{i}$.

Auch daß geladene Teilchen, die nicht durch ein elektrisches Feld, sondern durch irgendwelche Mechanismen in Bewegung gehalten werden, ein magnetisches Feld um sich haben, ist nach dieser Auffassung der magnetischen Vorgänge zu verstehen. Denken wir uns zunächst einmal eine einzelne mit der Ladung e Coulomb versehene Kugel, die sich mit einer konstanten Geschwindigkeit v in der Richtung der x-Achse fortbewegt, so muß mit ihr zugleich der elektrische Zustand im umgebenden Raum in der positiven Richtung der x-Achse vorwärtsgehen. In dem Raumteil vor der Kugel muß also ein dauerndes Wachsen des elektrischen Zustandes eintreten, in dem Raumteil hinter ihr ein dauerndes Abnehmen. Diese Änderung des elektrischen Zustandes, also die Übertragung des elektrischen Feldes im Raum kann nur durch ein magnetisches Feld bewirkt werden, welches die Kugel und ihr elektrisches Feld begleitet. Bewegt sich die Kugel mit der konstanten Geschwindigkeit v, und geht das elektrische Feld mit ihr, ohne sich sonst zu verändern, so müssen sich die Komponenten der elektrischen Erregung $\mathfrak{D}$ als Funktion des Ortes relativ zum Zentrum der Kugel berechnen lassen. Sind die Koordinaten des Kugelzentrums zur Zeit t als (ξ, 0, 0,) bezeichnet ($d\xi/dt = v$), so hängen die Komponenten des Vektors $\mathfrak{D}$ in einem festen Punkt des Raumes (x, y, z) demnach nur von den Größen ($x - \xi$, y, z) ab, sie enthalten die Zeit t nur implizite, insofern ξ eine Funktion der Zeit ist, und der Verschiebungsstrom berechnet sich daher als:

$$\frac{\partial \mathfrak{D}}{\partial t} = \frac{\partial \mathfrak{D}}{\partial \xi} \cdot \frac{d\xi}{dt} = - \frac{\partial \mathfrak{D}}{\partial x} \cdot v.$$

Infolge der Symmetrie der bewegten Kugel muß $\mathfrak{D}$ überall ganz in den durch die x-Achse gehenden Meridianebenen verlaufen, $\mathfrak{D}$ ist also aus den folgenden zwei Komponenten zusammengesetzt: $\mathfrak{D}_x$ parallel zur Bewegungsrichtung, $\mathfrak{D}_r$ in der Richtung des Abstandes r des Aufpunktes (x, y, z) von der x-Achse ($r = \sqrt{(x-\xi)^2 + y^2 + z^2}$). Eine leichte Rechnung ergibt: $\operatorname{div} \mathfrak{D} = \frac{1}{r} \cdot \frac{\partial (r \cdot \mathfrak{D}_r)}{\partial r} + \frac{\partial \mathfrak{D}_x}{\partial x}$. Dieser Wert stellt zugleich die Raumdichte ϱ der elektrischen Ladung dar, er ist nur auf der Oberfläche (oder auch im Innern) der Kugel von Null verschieden, und $\varrho \cdot \mathfrak{v} = \mathfrak{i}$ ist der elektrische Leitungsstrom. Aus der Symmetrie folgt ferner, daß das magnetische Feld $\mathfrak{H}$ in Kreisen um die x-Achse herumgeht. Die beiden Komponenten von $\mathfrak{rot}\, \mathfrak{H}$ sind:

$$(\mathfrak{rot}\, \mathfrak{H})_x = \frac{1}{r} \frac{\partial (r \cdot H)}{\partial r}, \qquad (\mathfrak{rot}\, \mathfrak{H})_r = - \frac{\partial H}{\partial x}.$$

Das MAXWELLsche Grundgesetz liefert demnach die folgenden beiden Gleichungen:

$$(1)\qquad \frac{1}{r}\cdot\frac{\partial(r\cdot H)}{\partial r}=\frac{\partial D_x}{\partial t}+\varrho\cdot v=\frac{1}{r}\frac{\partial(r\cdot D_r)}{\partial r}\cdot v$$

$$(2)\qquad -\frac{\partial H}{\partial x}=\frac{\partial D_r}{\partial t}=-\frac{\partial D_r}{\partial x}\cdot v.$$

Beide Gleichungen ergeben übereinstimmend:

$$H = D_r \cdot v$$
$$\mathfrak{H} = [\mathfrak{v}\cdot\mathfrak{D}].$$

Wenn wir in dem Aufpunkt (x, y, z) ein Linienelement ds auf dem durch den Aufpunkt gehenden zur Figurenachse konzentrischen Kreis und ein Linienelement dx parallel zur Achse legen, so daß ein kleines Rechteck vom Inhalt $df = dx \cdot ds$ entsteht, so ist $D_r \cdot df$ die Zahl der durch df hindurchtretenden elektrischen Erregungslinien, und wenn dt die Zeit ist, während welcher der Weg d x zurückgelegt wird, also $v \cdot dt = dx$, $dt = \frac{dx}{v}$, so ist $D_r \cdot df$ die Zahl der Erregungslinien, welche das Linienelement ds in der Zeit dt schneiden. Umgerechnet auf 1 cm und auf 1 sec ist die Zahl der schneidenden Linien also $D_r \cdot v$.

Die magnetische Erregung in der Umgebung einer mit konstanter Geschwindigkeit bewegten elektrisch geladenen Kugel berechnet sich gleich der Zahl der elektrischen Erregungslinien, die ein zu $\mathfrak{D}$ und zu $\mathfrak{v}$ senkrechtes Linienstück pro Zentimeter und pro Sekunde schneiden.

Das magnetische Feld eines Konvektionsstromes haben wir uns so zustande kommend zu denken, daß jedes einzelne der geladenen Elementarteilchen (Ionen oder Elektronen) auf dem bewegten Körper von einem Feld umgeben ist, das sich nach der eben gewonnenen Formel berechnet. Alle diese Felder erstrecken sich bis in unendliche Entfernungen, weil bei einem stationären Vorgang in großen Entfernungen, wo man ein konstantes elektrisches Feld hat, überall die Bedingung $\mathrm{rot}\,\mathfrak{H} = 0$ erfüllt sein muß. Durch Addition all der Felder nach dem Prinzip der Superposition entsteht das weit ausgedehnte, der Beobachtung zugängliche magnetische Feld.

Ebenso können wir natürlich auch das magnetische Feld eines Leitungsstromes auffassen, jedes einzelne Elektron oder Ion ist von seinem Magnetfeld umgeben, und das weit ausgedehnte starke magnetische Feld um den Stromleiter kommt dadurch zustande, daß in größeren Entfernungen von den Ionen überall die Bedingung $\mathrm{rot}\,\mathfrak{H} = 0$ erfüllt sein muß. Diese Auffassung ist mit der oben geschilderten Auffassung, nach welcher das magnetische Feld die Funktion hat, das durch die Ionenbewegung fortwährend zerfallende Feld immer wieder aufzurichten, keineswegs in Widerspruch, denn die Forderung, daß das elektrische Feld im Leiter unvermindert bleibt, liefert eben gerade die für das Auftreten des äußeren Feldes wesentliche Bedingung, daß in großen Entfernungen von den Ionen $\mathrm{rot}\,\mathfrak{H} = 0$. Man kann sich auch Leitungsströme denken, bei welchen keine Wiederaufrichtung des elektrischen Feldes stattfindet. Wenn man beispielsweise einen Plattenkondensator mit schwach leitendem Dielektrikum auflädt und ihn sich dann selber überläßt, so wird infolge des schwachen Leitungsstromes im Dielektrikum das Feld allmählich zusammenbrechen. Dieser Leitungsstrom erzeugt in der Umgebung des Dielektrikums kein magnetisches Feld, weil $d\mathfrak{D}/dt$ nicht Null ist. Makroskopisch gerechnet ist $i + \frac{d\mathfrak{D}}{dt} = 0$, das ergibt $\mathfrak{H} = 0$.

§ 2. Experimentelle Untersuchungen über das magnetische Feld von Verschiebungsströmen.

Schon Röntgen[1]) hat die magnetische Wirkung von Verschiebungsströmen beobachtet. Er ließ eine horizontale Ebonitscheibe von 16 cm Durchmesser und 0,5 cm Dicke um eine vertikale Achse zwischen zwei unbeweglichen ringförmigen Stanniolbelegungen rotieren. Die untere Belegung war in zwei voneinander isolierte Halbringe geteilt, die auf entgegengesetzte Potentiale geladen wurden. Die obere Belegung war dauernd geerdet. Bei jeder Umdrehung der Scheibe wechselte demnach die dielektrische Polarisation in ihr zweimal das Zeichen und so entstanden an den beiden Trennungslinien der Halbringe zwei konstante, vertikale Verschiebungsströme von entgegengesetzter Richtung. Dicht über der oberen Platte hing die untere Nadel eines astatischen Nadelpaares, und zwar so, daß ihre Mitte sich genau über der Achse der Rotation befand. Ihre Richtung war in der Ruhelage die der Trennungslinie der beiden entgegengesetzt geladenen Plattenhälften. Auf die Nadel in dieser Lage muß das magnetische Feld der kurzen vertikalen Verschiebungsströme wirken. Beim Kommutieren der Ladung, während die Scheibe rotierte, beobachtete Röntgen tatsächlich Ausschläge, doch waren sie so klein, daß er erst nach großer Übung „bei seinen letzten Versuchen die Ablenkungsrichtung fast ausnahmslos richtig angeben konnte".

Denselben Versuch wiederholte A. Eichenwald mit der schon auf S. 60 beschriebenen rotierenden Ebonitscheibe, indem er die beiden

[1]) W. C. Röntgen, Sitzgsber. d. kgl. preuß. Akad. d. Wissensch. Berlin, 1885, S. 195.

Platten des Kondensators durch je einen vertikalen Schnitt in zwei Hälften teilte und nun die beiden Kondensatorhälften entgegengesetzt auflud (Fig. 27, A_s und A_n). Das Magnetometer wurde bei diesem Versuch gerade über dem Schlitz angebracht, und zwar so, daß die Nadel in der Ruhestellung der Rotationsachse parallel gerichtet war. Die erwartete Ablenkung trat wirklich ein, sie betrug bei Potentialdifferenzen zwischen 6720 und 7360 Volt, bei 100 Umdrehungen pro Sekunde und bei einem Skalenabstand von 230 cm 5—6 mm. Nachher wurde die Hartgummischeibe durch eine Holzscheibe ersetzt, in welcher Kupferdrähte eingebaut waren, die den Weg der Konvektionströme und des sie schließenden zur Scheibenebene senkrecht gehenden Verschiebungsstromes nachahmten. Es wurde dann die magnetische Wirkung dieser Ströme untersucht, und nach einem ähnlichen Verfahren, wie es EICHENWALD schon bei den reinen Konvektionsströmen mit der Hartgummischeibe angewendet hatte (vgl. S. 61), der Leitungsstrom errechnet, der dieselbe Ablenkung der Magnetnadel ergeben hätte, wie der Verschiebungsstrom. Der Wert stimmte innerhalb einiger Prozent Fehler mit dem theoretisch zu erwartenden überein.

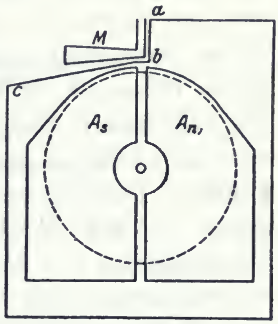

Fig. 27.
EICHENWALDS Versuch über Verschiebungsströme.

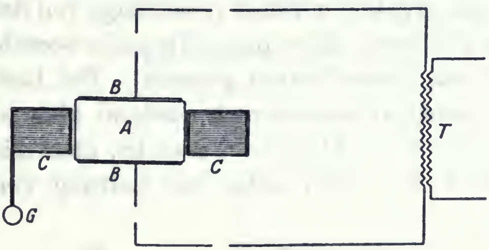

Fig. 28. Versuch von J. B. WHITEHEAD über Verschiebungsströme.

In den beschriebenen Versuchen von RÖNTGEN und von EICHENWALD handelt es sich um Ströme, die darin bestehen, daß die Dipole in einem materiellen Dielektrikum umgekehrt werden. Diese Ströme sind also im Grunde doch auch nur Bewegungen geladener Teilchen, es sind noch keine Verschiebungsströme im strengsten Sinne des Wortes. Nur aus diesem Grunde war es möglich, sie in Form eines stationären Stromes mit einer konstant abgelenkten Magnetnadel zu beobachten. Die eigentlichen Verschiebungsströme, die auch im Vakuum auftreten, können der Natur der Sache nach nur als Wechselströme beobachtet werden.

S. P. THOMPSON[1]) untersuchte das magnetische Feld des Verschiebungsstromes in einem Plattenkondensator, dessen Dielektrikum Paraffin

[1]) S. P. THOMPSON, Pr. Roy. Soc. 45, 392. 1889.

war, wenn dem Kondensator Wechselstrom zugeführt wurde. In das Paraffin war parallel zu den Platten ein mit einer Spule umwickelter Eisenring eingebettet. Als Wechselstromquelle diente ein Induktorium. An die Enden der Spule war ein Telephon angeschlossen, mit welchem man den durch das magnetische Wechselfeld in der Spule induzierten Strom beobachten konnte. Genauere Versuche stellte nach einem ähnlichen Prinzip J. B. WHITEHEAD im Jahre 1905 an[1]). Der Apparat ist Fig. 28 skizziert. Das Dielektrikum A eines Plattenkondensators (B, B) ist von einem Ring aus lamelliertem Eisen (C, C) von 41,4 cm innerem und 82,8 äußerem Durchmesser umgeben, um diesen Eisenkern ist eine Ringspule von 966 Windungen gewickelt. Dem Kondensator wurde ein Wechselstrom von der Frequenz 133 pro Sekunde von einem Wechselstromgenerator über einen Transformator zugeführt, die effektive Spannung betrug 25000 Volt. Die Kapazität des Kondensators (Fläche 1164 cm^2, Dicke des Dielektrikums 20 cm, $\varepsilon = 2{,}0$ für Paraffin) läßt sich schätzungsweise auf $1{,}03 \cdot 10^{-11}$ Farad berechnen, es ist danach ein Strom von etwa $2 \cdot 10^{-4}$ Amp effektiv zu erwarten, merkwürdigerweise wurde er nicht gemessen, soweit man aus den Angaben sehen kann. An die Induktionsspule wurde ein Vibrationsgalvanometer (G) nach RUBENS[2]) angeschlossen, dessen Empfindlichkeit vorher bestimmt war. Man konnte unter der Annahme einer Permeabilität des Eisens $\mu = 183$ (für schwache Magnetfelder) den am Vibrationsgalvanometer zu erwartenden Effekt vorher berechnen. Die Beobachtungen ergaben wirklich Ausschläge von der Größenordnung des berechneten Effektes. Es wurden Versuche sowohl mit Paraffin, wie auch mit Luft als Dielektrikum gemacht. Bei Luft waren die Ausschläge des Vibrationsgalvanometers bedeutend kleiner, allerdings nicht gerade im Verhältnis 1:2. Ähnliche Versuche, aber mit Hochfrequenz, hat im Jahre 1910 E. KOCH[3]) unter der Leitung von FR. RICHARZ ausgeführt.

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[1]) J. B. WHITEHEAD, Physikal. Z. 6, 474. 1905. [2]) H. RUBENS, Wied. Ann. 56, 27. 1895. [3]) E. KOCH, Dissertation, Marburg 1910; ferner FR. RICHARZ, Naturwissensch. 4, 741. 1916.

BERGMANN-SCHAEFER

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ZUM GEBRAUCH BEI AKADEMISCHEN VORLESUNGEN UND ZUM SELBSTSTUDIUM

Band II

Elektrizität und Magnetismus

6., neubearbeitete und erweiterte Auflage

mit 688 Abbildungen

Von

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Technischen Universität Berlin

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39. Der Verschiebungsstrom; Hauptgleichung des Elektromagnetismus

Bereits mehrfach sind wir auf die Bedeutung der Frage gestoßen, ob alle elektrischen Ströme geschlossen sind. Auf den Seiten 178 und 229 wurde darauf aufmerksam gemacht, daß jedem Elementargesetze (z. B. dem von Biot-Savart und dem Ampèreschen) noch unzählig viele andere abweichender Gestalt gleichwertig sind, da sie sämtlich für geschlossene Ströme das gleiche Ergebnis liefern. Das liegt daran, daß die verschiedenen Formen der gleichwertigen Elementargesetze sich voneinander nur durch additive Glieder unterscheiden, deren Summe für einen geschlossenen Stromkreis verschwindet. Daraus ergibt sich umgekehrt, daß man zwischen den verschiedenen (für geschlossene Ströme gleichwertigen) Elementargesetzen würde unterscheiden können, d. h. das allein „richtige" würde bestimmen können, wenn es ungeschlossene Ströme gäbe. Denn für die Stromenden liefert natürlich jede Variante der Elementargesetze andere Werte. Ferner ist leicht zu sehen, daß die Gl. (156′) des Elektromagnetismus auf S. 179

$$\oint |\mathfrak{H}_s| \, ds = \frac{4\pi}{c} J \tag{156′}$$

nur dann allgemein gültig sein kann, wenn die Strombahn wirklich geschlossen ist; denn diese Gleichung enthält eine allgemeine Aussage über die Verknüpfung der Ströme mit ihrem Magnetfeld; hat aber der Strom eine Unterbrechungsstelle, so kann Gl. (156′) für deren Umgebung offenbar nicht mehr gelten.

Gibt es also ungeschlossene Ströme? Zunächst ist festzustellen, daß alle stationären Ströme sämtlich geschlossen sind, mögen sie wie auch immer erzeugt sein; aber bei nichtstationären Strömen könnte es anders sein. Für solche hat die ältere Elektrodynamik diese Frage unbedenklich bejaht, und als Beispiel etwa auf den Fall verwiesen, daß ein Kondensator durch einen die beiden Platten verbindenden Draht geladen oder entladen wird: Dann endigt oder beginnt der Leitungsstrom an den Kondensatorplatten. Es scheint kaum möglich, über diesen Fall anderer Meinung zu sein. Demgemäß hat man früher vielfach an derartig ungeschlossenen Leitungsströmen in der Hoffnung experimentiert, aus der Mannigfaltigkeit der gleichwertigen Elementargesetze eines als das „richtige" herausheben zu können. Wegen der großen experimentellen Schwierigkeiten haben diese Untersuchungen kein Ergebnis gehabt. !?!

Auf einem radikal anderen Wege sucht J. Cl. Maxwell die Lösung dieses Problems. Er bestreitet — natürlich! — nicht, daß zwischen den Kondensatorplatten der Leitungsstrom unterbrochen ist; aber er behauptet, daß auch im Dielektrikum des Kondensators eine Art von Strömen existiere, die den Leitungsstrom zu einem geschlossenen ergänze. Wie kommt Maxwell zu dieser Behauptung? Bleiben wir beim Beispiel der Kondensator-Ladung oder -Entladung, so existiert in jedem Augenblicke im Inneren des Kondensators eine dielektrische Verschiebung $\mathfrak{D} = \varepsilon\,\mathfrak{E}$, die nach Gl. (41) auf Seite 45 der Gleichung gehorcht $|\mathfrak{D}_n| = 4\pi\eta$, wobei η die augenblickliche Flächendichte der Ladung des Kondensators ist; da die $\mathfrak{D}$-Linien senkrecht von den Leitern ausgehen und auf ihnen endigen, ist hier $\mathfrak{D}_n$ gleich dem Gesamtbetrage von $\mathfrak{D}$; also geht die letzte Gleichung über in:

$$|\mathfrak{D}| = 4\pi\eta.$$

Erweitern wir diese Gleichung mit A, der Fläche der Kondensatorplatten, so wird ηA gleich der Gesamtladung q:

$$|\mathfrak{D}|\, A = 4\pi q,$$

und wenn man diese Gleichung nach t differenziert und beachtet, daß gemäß der Definition der Stromstärke $\frac{dq}{dt} = J$ ist, so folgt weiter:

$$\frac{A}{4\pi}\left|\frac{d\mathfrak{D}}{dt}\right| = J. \tag{191}$$

Die linksstehende, für das Dielektrikum des Kondensators definierte Größe ist also numerisch gleich der Intensität des Leitungsstromes; wenn es nun möglich ist, den Ausdruck $\left|\frac{d\mathfrak{D}}{dt}\right| \frac{A}{4\pi}$ als Strom zu interpretieren, so kann man in der Tat behaupten, daß diese neue Stromart, die Maxwell als **„Verschiebungsstrom"** bezeichnet, den offenen Leitungsstrom schließt.

Maxwell argumentiert nun so: Der Verschiebungsvektor $\mathfrak{D}$ bedeutet, wie der Name anzeigt, eine wirkliche Verschiebung der in den Volumelementen des Dielektrikums vorhandenen positiven und negativen Ladungen: Die positiven werden in, die negativen entgegen der Richtung des Feldes auseinandergeschoben, wie in Nr. 13 ausführlich dargelegt wurde. Solange das Feld im Inneren zeitlich konstant ist, bleiben die Ladungen unverändert in ihrer (verschobenen) Ruhelage; ändert sich dagegen $\mathfrak{D}$ zeitlich — und das ist der Fall während des Ladungs- und Entladungsvorganges —, so bewegen sie sich, indem sie bei Zunahme von $\mathfrak{D}$ weiter auseinanderrücken, bei Abnahme entsprechend sich einander nähern. Jede Bewegung elektrischer Ladungen ist aber ein echter Strom, und somit ist es in der Tat möglich, die Größe $\frac{A}{4\pi}\left|\frac{d\mathfrak{D}}{dt}\right|$ als Stromstärke zu bezeichnen. Die Stromdichte $\mathfrak{j}_v$ des Verschiebungsstromes ergibt sich nun nach Division von (191) durch A zu

(192)
$$\mathfrak{j}_v = \frac{1}{4\pi}\frac{d\mathfrak{D}}{dt}.$$

Im Kondensator herrscht — mit Ausnahme an den Rändern — ein homogenes $\mathfrak{D}$-Feld; wo dies nicht der Fall ist, ist die Stromstärke J_v des Verschiebungsstromes durch den allgemeineren Ausdruck gegeben

(193)
$$J_v = \int |\,\mathfrak{j}_{vn}\,|\, dA = \frac{1}{4\pi}\int \frac{d\,|\,\mathfrak{D}_n\,|}{dt}\, dA,$$

wo $\mathfrak{j}_{vn}$ die zum Flächenelement dA normale Komponente bedeutet, genau so wie

(194)
$$J_l = \int |\,\mathfrak{j}_{ln}\,|\, dA$$

ist; vgl. Gl. (119) auf S. 124. Im allgemeinen ist es nun so, daß Leitungs- und Verschiebungsstrom nicht räumlich getrennt sind, sondern nebeneinander bestehen, da jeder Leiter auch eine Dielektrizitätskonstante (die freilich unbekannt ist), jedes Dielektrikum auch ein Leitvermögen besitzt: In der Natur existieren nur „Halbleiter“ [1]), da sowohl vollkommene Leiter wie vollkommene Isolatoren nur Abstraktionen sind. Wir haben also an jeder Stelle als Gesamtstrom J die Summe $J_l + J_v$ zu betrachten, und diese ist nach (193) und (194)

$$J = J_l + J_v = \int |\,\mathfrak{j}_{ln}\,|\, dA + \int |\,\mathfrak{j}_{vn}\,|\, dA = \int |\,(\mathfrak{j}_l + \mathfrak{j}_v)_n\,|\, dA.$$

Setzt man für $\mathfrak{j}_l$ nach dem Ohmschen Gesetz [in der Differentialformulierung (132) von S. 140] den Wert $\sigma\mathfrak{E}$, für $\mathfrak{j}_v$ den in (192) angegebenen Betrag ein, so folgt für den Gesamtstrom:

(195)
$$J = J_l + J_v = \int \left|\left(\sigma\,\mathfrak{E} + \frac{1}{4\pi}\frac{d\mathfrak{D}}{dt}\right)_n\right| dA = \int \left|\left(\sigma\,\mathfrak{E} + \frac{\varepsilon}{4\pi}\frac{d\mathfrak{E}}{dt}\right)_n\right| dA.$$

Diesen Wert haben wir in der Gl. (156) von S. 175 einzusetzen, womit sie ihre endgültige Gestalt erhält:

(196)
$$\oint |\,\mathfrak{H}_s\,|\, ds = \frac{4\pi}{c}\int \left|\left(\sigma\,\mathfrak{E} + \frac{\varepsilon}{4\pi}\frac{d\mathfrak{E}}{dt}\right)_n\right| dA.$$

In dieser verallgemeinerten Form bezeichnen wir (196) als die Hauptgleichung des Elektromagnetismus und betrachten sie mit Maxwell als allgemein gültig.

Dazu ist noch eine wichtige Bemerkung zu machen: dA ist ein Element eines durch die Strombahn gelegten Querschnittes; durch jedes Element tritt die normale Komponente sowohl des Leitungsstromes wie des Verschiebungsstromes hindurch; die Anteile jedes einzelnen Elementes $|\,(\mathfrak{j}_l + \mathfrak{j}_v)_n\,|\, dA$ werden über den ganzen Querschnitt summiert und ergeben so den Gesamtstrom J. Auf der linken Seite von (196) steht der Ausdruck $\oint |\,\mathfrak{H}_s\,|\, ds$, das Linienintegral der magnetischen Feldstärke längs einer den Strom umzingelnden Kurve s. Wir wollen nun unter A eine beliebige Fläche verstehen, die durch s berandet wird; diese schneidet natürlich die Strombahn in einem Querschnitt A, und über diesen allein haben wir bisher integriert, um den Gesamtstrom J zu erhalten. Wir können aber ebenso gut über die ganze Fläche A' summieren; denn soweit sie außerhalb der Strombahn liegt, ist ja der sie durchsetzende Strom gleich Null; diese Teile liefern also keinen Beitrag zu der Summe $\int |\,(\mathfrak{j}_l + \mathfrak{j}_v)_n\,|\, dA$; es ist vielmehr $\int |\,(\mathfrak{j}_l + \mathfrak{j}_v)_n\,|\, dA = \int |\,(\mathfrak{j}_l + \mathfrak{j}_v)_n\,|\, dA'$. Wir haben aber jetzt den Vorteil, daß wir bezüglich der Gl. (196) sagen können, daß links über eine Kurve s summiert wird, die den Stromleiter umschlingt, rechts über eine beliebige Fläche A, die von s berandet wird. (Den Strich an A' können wir nunmehr wieder fortlassen.)

Es ergibt sich aus dem Vorhergehenden, daß ein Verschiebungsstrom nur dann auftritt, wenn es sich um nichtstationäre Vorgänge handelt — $\mathfrak{D}$ bzw. $\mathfrak{E}$ müssen sich ja zeitlich ändern —

[1]) Diese von Maxwell eingeführte Bezeichnung erscheint heute nicht mehr zweckmäßig, da man nach den Ausführungen von S. 491 etwas anderes darunter versteht.

für stationäre Ströme ist er nicht vorhanden. Je schneller die zeitliche Änderung stattfindet, um so mehr tritt der Verschiebungsstrom hervor.

Die Stromdichte des Verschiebungsstromes können wir etwas anders schreiben, wenn wir uns daran erinnern, daß nach Gl. (50) auf Seite 54

$$\mathfrak{D} = \mathfrak{E} + 4\pi\mathfrak{P} = \mathfrak{E} + (\varepsilon - 1)\mathfrak{E}$$

ist, wo $\mathfrak{P}$ die Polarisation des Dielektrikums bedeutet. Die Dichte $\mathfrak{j}_v$ des Verschiebungsstromes wird damit nach Gl. (192)

$$\mathfrak{j}_v = \frac{1}{4\pi}\frac{d\mathfrak{D}}{dt} = \frac{1}{4\pi}\frac{d\mathfrak{E}}{dt} + \frac{d\mathfrak{P}}{dt} = \frac{1}{4\pi}\frac{d\mathfrak{E}}{dt} + \frac{\varepsilon-1}{4\pi}\frac{d\mathfrak{E}}{dt}\,. \tag{197}$$

Der erste Summand $\frac{1}{4\pi}\frac{d\mathfrak{E}}{dt}$ ist die Verschiebungsstromdichte im Vakuum, $\frac{d\mathfrak{P}}{dt} = \frac{\varepsilon-1}{4\pi}\frac{d\mathfrak{E}}{dt}$ diejenige im Dielektrikum, die sinngemäß als **Polarisationsstromdichte** bezeichnet wird. Maxwell selbst trug kein Bedenken, das erste Glied $\frac{1}{4\pi}\frac{d\mathfrak{E}}{dt}$ als **Polarisationsstrom des Vakuums** zu betrachten, was wir heute für nicht mehr zulässig halten, da wir in den Volumelementen des reinen Vakuums keine elektrischen Ladungen annehmen können. Während für das zweite Glied $\frac{d\mathfrak{P}}{dt} = \frac{\varepsilon-1}{4\pi}\frac{d\mathfrak{E}}{dt}$ die oben gegebene anschauliche Deutung (Verschiebung von elektrischen Ladungen) zutrifft, fehlt eine solche durchaus für den Verschiebungsstrom im Vakuum. Es ist also eine neue Hypothese, eine allgemeinere Stromdefinition, die hier vorliegt. Sie besagt, daß jede zeitliche Änderung eines elektrischen Feldes $\left(\frac{d\mathfrak{E}}{dt} \neq 0\right)$ einen echten elektrischen Strom darstellt, der auch die gleichen magnetischen Wirkungen haben soll wie jeder Leitungs- und Polarisationsstrom. Diese Hypothese ist das eigentlich Neue der Maxwellschen Elektrodynamik gegenüber der alten Theorie; sie hat sich als von fundamentaler Bedeutung erwiesen. H. Hertz hat für die Richtigkeit dieser Hypothese durch seine Entdeckung der elektrischen Wellen 1888/89 den Nachweis erbracht.

Daß der Polarisationsstrom $\frac{d\mathfrak{P}}{dt}$ magnetische Wirkungen ausübt, hat u. a. A. Eichenwald durch besondere Versuche gezeigt, deren einen wir nun darlegen wollen. Eine runde Scheibe S aus einem Dielektrikum kann zwischen zwei Kondensatorplatten rotieren (Abb. 309). Diese sind in zwei voneinander isolierte halbkreisförmige Platten 1,2 und 3,4 geteilt, die in der gezeichneten Weise miteinander verbunden und aufgeladen sind. Dadurch werden die beiden Hälften des zwischen ihnen befindlichen Dielektrikums entgegengesetzt polarisiert. Rotiert das Dielektrikum zwischen den Platten, so muß es beim Übergang vom Plattenpaar 1,2 zu 3,4 seine Polarisationsrichtung umkehren. Dadurch entsteht ein Polarisationsstrom parallel der Rotationsachse, der sich durch die Ablenkung einer empfindlichen Magnetnadel M nachweisen läßt. Eichenwald hat insbesondere gezeigt, daß der so gemessene Polarisationsstrom proportional $(\varepsilon - 1)$ ist, wie es nach unserer Darlegung der Fall sein muß.

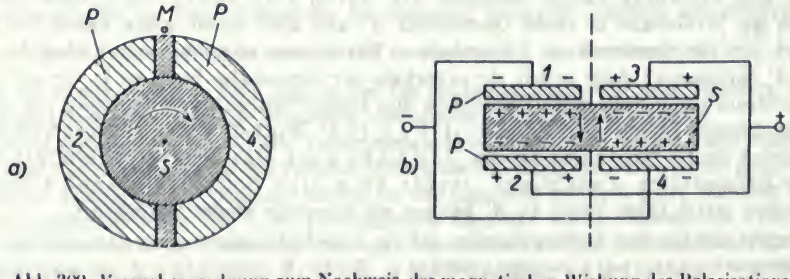

Abb. 309. Versuchsanordnung zum Nachweis der magnetischen Wirkung des Polarisationsstromes im Längs- (a) und Querschnitt (b)

Als Gesamtergebnis können wir also feststellen: **Ein sich zeitlich änderndes elektrisches Feld ist, da es einen echten Strom darstellt, von geschlossenen magnetischen Kraftlinien umgeben.** Abb. 310 soll dies zum Ausdruck bringen: Der Verschiebungsstrom $\mathfrak{j}_v = \frac{\varepsilon}{4\pi}\frac{d\mathfrak{E}}{dt}$, der von unten nach oben fließt, ist von magnetischen Kraftlinien umschlossen, deren positiver Umlaufssinn der rechten Handregel entspricht. Leider ist es nicht möglich, diese magnetischen Kraftlinien experimentell durch Eisenfeilpulver in der üblichen Weise sichtbar zu machen; dazu sind die Änderungen selbst stärkster elektrischer Felder zu schwach. Wir werden aber in Nr. 55 Versuche kennenlernen, die das Vorhandensein des durch Verschiebungsströme erzeugten Magnetfeldes zweifellos beweisen.

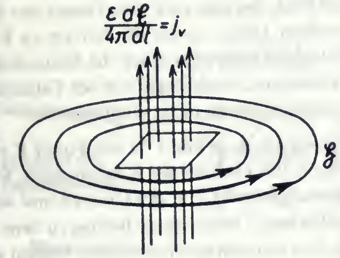

Abb. 310.
Magnetfeld eines Verschiebungsstromes

55. Elektromagnetische Raumwellen im Dielektrikum; offener Schwingungskreis; elektrischer Dipol und sein Strahlungsfeld; Hertzsche Versuche

Only the title of §55 is reproduced here to show that, besides Eichenwald's experiment presented on the previous page, there are no other DIRECT experiments demonstrating that displacement current generates magnetic field. The existence of electromagnetic radiation (due to the accelerated motion of the charges) can be not considered as an experimental confirmation that displacement current generates magnetic field. On the other hand (as Marinov shows in this book) Eichenwald's experiment is INCONCLUSIVE.

BERKLEY'S COURSE ON PHYSICS, p. 195, part II by E. M. Purcell

7.12. Der Verschiebungsstrom

Das Vektorfeld $\frac{1}{c}\frac{\partial E}{\partial t}$ scheint einen *Zusatzterm* zur Leitungsstromdichte darzustellen. *Maxwell* wählte als Bezeichnung dafür den Begriff *Verschiebungsstrom*, der auch heute noch verwendet wird, obwohl er sich als nicht sehr zweckmäßig herausstellte. Genauer können wir eine „Verschiebungsstromdichte" J_d definieren und von der Leitungsstromdichte J unterscheiden. Gl. (7.84) schreiben wir folgt:

$$\text{rot}\, B = \frac{4\pi}{c}(J + J_d), \tag{7.88}$$

womit wir die Verschiebungsstromdichte als $J_d = \frac{1}{4\pi}\frac{\partial E}{\partial t}$ definiert haben.

Wir mußten diesen neuen Term einführen, um die Beziehung zwischen Strom und Magnetfeld für den Fall zeitlich veränderlicher Leitungsströme mit der Kontinuitätsbedingung in Einklang zu bringen. Besteht der Term mit J_d in Gl. (7.88) zu Recht, muß er zu einer neuen Induktionserscheinung führen, bei der ein sich veränderndes elektrisches Feld von einem Magnetfeld begleitet wird. Warum entdeckte *Faraday* diese Erscheinung nicht? Er suchte gar nicht danach. Aber es gibt einen tieferen Grund, warum sich bei Experimenten, wie sie *Faraday* durchführte, keine neuen Effekte im Zusammenhang mit dem Verschiebungsstrom hätten aufdecken lassen. In jeder Apparatur, in der veränderliche elektrische Felder auftreten, sind zur selben Zeit auch Leitungsströme, d. h. in Bewegung befindliche Ladungen vorhanden. Das Magnetfeld B in einer Umgebung der Apparatur entspricht nahezu dem Feld, das man nach dem Gesetz von *Biot-Savart* berechnet. Dabei werden die Beiträge zu B in einem beliebigen Raumpunkt durch die Stromelemente des Leiters bestimmt, unabhängig von der Tatsache, daß der Leiter möglicherweise nicht geschlossen ist.

Betrachten Sie z. B. in Bild 7.31 den Punkt P zwisch den Platten des sich entladenden Kondensators. Jedes E ment des Leitungsstroms – in den Drähten und auf der Plattenoberflächen – liefert einen Beitrag zu dem Feld in P gemäß dem Biot-Savartschen Gesetz. Müssen wir au die Elemente des „Verschiebungsstroms" J_d berücksicl tigen? Die Antwort ist eher überraschend. Man *kann* J_d berücksichtigen; wenn man dabei sehr sorgfältig vorgeh und den *gesamten* „Verschiebungsstrom" einbezieht, wird sein Gesamteinfluß bei relativ langsam veränderlichen Feldern gleich *Null*.

Um zu verstehen, warum dies so ist, beachten Sie zunächst, daß die in Bild 7.30 durch schwarze Pfeile dargestellte Vektorfunktion J_d die gleiche Form wie das elektrische Feld E in Bild 7.29 hat. Abgesehen davon, daß es immer schwächer wird und langsam verschwinde ist E fast ein elektrostatisches Feld. Daher erwarten wir daß seine Rotation praktisch gleich Null ist, was wieder zur Folge hat, daß rot J praktisch gleich Null sein muß.

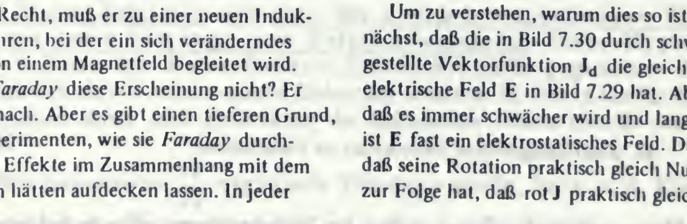

Bild 7.30. Leitungsstrom (weiße Pfeile) und Verschiebungsstrom (schwarze Pfeile).

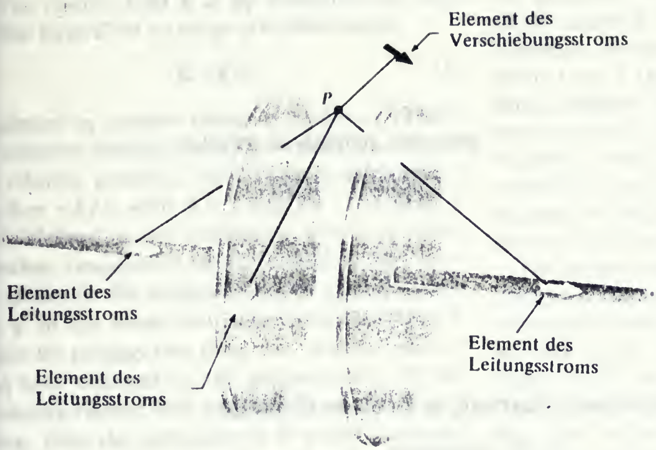

Bild 7.31
Bei sich langsam verändernden Feldern ist der von allen Verschiebungsströmen herrührende Gesamtbeitrag zu dem Magnetfeld in irgendeinem Punkt gleich Null. Das Magnetfeld in P läßt sich durch Anwendung des Biot-Savartschen Gesetzes auf den Leitungsstrom alleine berechnen.

xakter formuliert gilt: Wir gehen von $\mathrm{rot}\,\mathbf{E} = -\frac{1}{c}\frac{\partial \mathbf{B}}{\partial t}$ us und erhalten mit dem Verschiebungsstrom $_{\mathrm{l}} = \frac{1}{4\pi}\frac{\partial \mathbf{E}}{\partial t}$ bei Vertauschung der Reihenfolge der ifferentiation

$$\mathrm{rot}\,\mathbf{J}_d = \frac{1}{4\pi}\,\mathrm{rot}\left(\frac{\partial \mathbf{E}}{\partial t}\right) = \frac{1}{4\pi}\frac{\partial}{\partial t}(\mathrm{rot}\,\mathbf{E})$$

$$= -\frac{1}{4\pi c}\frac{\partial^2 \mathbf{B}}{\partial t^2}. \qquad (7.89)$$

ieser Term ist bei sich genügend langsam verändernden eldern vernachlässigbar klein; solche Felder bezeichnen ir als *quasistatisch.* Elektrostatische Felder lassen sich us den Feldern von Punktladungen aufbauen. Ist $\mathbf{J}_d$ un ein rotationsfreies Vektorfeld, kann man es ähnlich us der Überlagerung von radialgerichteten Strömen erzeugen, die von punktförmigen Quellen wegfließen oder u punktförmigen Senken hinfließen (Bild 7.32). Das agnetische Feld einer beliebigen *radialen* symmetrischen Stromverteilung ist aber, *nach* Biot-Savart berechnet, aus Symmetriegründen gleich Null, da es außer der Radialrichtung selbst nirgends eine ausgezeichnete Richtung gibt.

Bei *quasistatischen* Feldern benötigt man demnach nur die Leitungsströme als Quellen des magnetischen Feldes. Anders gesagt, hätte *Faraday* mit einer Anordnung, wie sie etwa Bild 7.31 zeigt, gearbeitet und das Magnetfeld in P z. B. mit einer Kompaßnadel messen können, wäre er nicht überrascht worden. Er hätte sich auch keinen Verschiebungsstrom einfallen lassen müssen, um sein Meßergebnis zu erklären.

Zum Nachweis dieses neuen Induktionseffektes benötigen wir rasch veränderliche Felder; die Änderungen müssen während einer Zeitdauer erfolgen, die vergleichbar ist mit jener, die das Licht zur Ausbreitung innerhalb der Apparate benötigt. Deshalb gelang erst *Hertz,* dessen Experimente viele Jahre nach *Maxwells* Entdeckung des Gesetzes kamen, der direkte Nachweis.

arinov's note. Purcell's presentation shows clearly that the Maxwellians do NOT understand what is "displacement current". The calculation of the magnetic intensity y the help of the Biot-Savart law (i.e., by the action of the conduction current) and by he help of the "displacement current" term in Maxwell's equations leads EXACTLY TO THE AME NUMERICAL RESULT. These two calculations are TWO FACES OF THE SAME COIN. Any action n external currents at point P in fig. 7.31 comes from the conduction currents in the onductors and any reaction of the external currents at point P is "absorbed" by the conuction currents. There is NO displacement current, both for low and high frequency conuction currents.

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Displacement Current, A Useless Concept

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The Maxwell relation, $\text{curl}\mathbf{B}=(\mu k/c)\partial\mathbf{E}/\partial t+4\pi\mu\mathbf{j}$, is obtained directly by differentiation without mention of displacement current. It is also deduced as a consequence of propagation with speed c, and the form of the expressions chosen for the fields **E** and **H**. These methods of examining retarded action of charge on charge have the advantage over emphasis on continuous fields that weaknesses of classical theory become evident, and closer correlation with symmetric propagation theories becomes possible.

THE situation today, regarding the concept of Maxwell's displacement current, is in some respects analogous to that existing thirty years ago regarding the fictitious magnetic pole. Having listened with discomfort in earlier years to explanations that the pole was fictitious, although it shared the basis of elementary electric theory equally with electric charge, the writer resolved with the ardor of youth to do what he could about it. Perhaps one should not be less assiduous, in this age of postulates and invention of particles, in emphasizing the alternative and more logical description of experimental facts which is possible with the number of independent concepts reduced further by omitting the displacement current. One contribution to the pole problem was entitled "The magnetic pole, a useless concept."[1] Even when employing $\Sigma p/r^2=\Sigma(NiA/l)/r^2$ as a mathematical de vice for computing magnetic fields outside a solenoid or magnet, the concept of magneti pole as a source of field is not so useful as th concept that p is simply a convenient symbo representing the product of current and are (magnetic moment) divided by (equivalent length. Probably a smaller percentage of physi cists now would denounce the displacement cur rent as fictitious and obsolete than were willin to describe the magnetic pole in these term thirty or more years ago. Yet for a long time, a number of physicists have noted the logica fallacy of a loose assertion which persists in a number of books—that a changing electric fiel produces a magnetic field or that a changin magnetic field produces an electric field. The have preferred to say that a steadily movin charge produces (i.e., is the source of) both a changing electric field and a steady magneti field, and that an accelerated charge produce both a changing magnetic field and an induce (accelerational) electric field.

[1] F. W. Warburton, Am. J. Phys. 2, 1 (1934). Perhaps a better phrase in the title of the 1934 paper and in this 1954 paper would be, "A Worse than Useless Concept"; for the endeavor has been to aid the reader in recognizing the damage done and the delays made by clinging to loose concepts and by failing to accept or to use freely the more concrete and specific descriptions of electrical phenomena.

The electric field $\mathbf{E}$ is by definition the ratio f the force $\mathbf{F}$ on a charge q to the charge

$$\mathbf{E}=\mathbf{F}/q, \qquad (1)$$

roduced by another charge q', either as a result f relative position only, $\mathbf{E}_s=\int \mathbf{r}dq'/r^3$, or due o relative position, velocity and acceleration, 1 $\mathbf{E}_i=-\dot{\mathbf{A}}/c$, with $\mathbf{A}=\int \mathbf{v}'dq'/cr$. The field $\mathbf{E}$ hus defined is not something which produces nother (magnetic) force. It depicts the state f affairs in the neighborhood of q' and caused y q' in the sense that, when due allowance is nade for propagation time, the "state of affairs" as been changed by the presence of q'. If the hanging electric field were the cause of magnetic orce, then the definition of $\mathbf{E}$ would be inadequate. Tacking such an extraneous meaning nto $\mathbf{E}$ after its definition in Eq. (1), is not conlucive to clear thinking on the part of the stulent. On the other hand, showing that a changing lectric field is accompanied by a magnetic field, oth related to the presence of a moving charge q' at a distance r at a sufficiently previous time $t-r/c$, strains neither the fictitious elastic ether nor the student's credulity. The concept that such a charge q' can be the source of both the changing electric field and the accompanying magnetic field is the less confusing and is sufficiently complete.

The magnetic field vector $\mathbf{B}$ is by definition the ratio of the transverse magnetic force on a current element to the product of the current and its length given by

$$\mathbf{F}=i\mathbf{l}\times\mathbf{B}, \qquad (2)$$

with $\mathbf{B}$ set up by a primary current, $\mathbf{B}=\oint i'd\mathbf{l}'\times\mathbf{r}/r^3$, and is not something which produces another (electric) force. It describes the state of affairs as measured by the test current $i\mathbf{l}$ in the region around and "produced by" i'. It is well to remember that in the case of the fixed primary current and changing mutual inductance the induced electric field computed from $\int \mathbf{E}_i\cdot d\mathbf{l} = -(1/c)d(\int \mathbf{B}\cdot d\mathbf{S})/dt = -\int \mathbf{B}\cdot(\mathbf{v}\times d\mathbf{l}/c) = \int (\mathbf{v}\times\mathbf{B}/c)\cdot d\mathbf{l}$ is literally and identically a component of the magnetic force per unit charge, $\mathbf{E}=\mathbf{v}\times\mathbf{B}/c$, and is not a new force "caused by" the magnetic force.[2] To insist that $\mathbf{v}\times\mathbf{B}/c$ or $d\mathbf{B}/dt$ causes $\mathbf{E}_i$ not only is redundant but it introduces serious confusion of ideas. The proposition that a changing intermediary field produces another kind of field reminds one uncomfortably of the "ox which began to drink the water which began to quench the fire which started to burn the stick which accelerated its beating the dog which changed his rate of biting the pig until the pig jumped over the stile."

The magnetic pole and the displacement current were reasonable physical concepts before it became known how well the action of charges on each other, after the propagation time, replaces the "lines of force" of magnets and the "strain in the (solid elastic) ether." Now that the ether is gone and we do not visualize $\mathbf{D}$ in vacuum as a physical displacement of charge past the point at which $\mathbf{D}$ is computed, retention of the name "displacement" for $\mathbf{D}=k\mathbf{E}/4\pi$ with the suggestion that it is needed for Maxwell's displacement current adds an element of vagueness and mystery which is quite unnecessary. Indeed it is misleading. The student is encouraged to believe that the vacuous concept of current in space where there are no electrons is responsible for the magnetic field between the condenser plates, whereas the origin $x'y'z'$ of the vector $\mathbf{r}=\mathbf{i}(x-x')+\mathbf{j}(y-y')+\mathbf{k}(z-z')$ in the equations used for computing both $\mathbf{B}$ and $d\mathbf{E}/dt$ locates the source at the charge q' at $x'y'z'$ producing both fields at the point xyz.

Developing the relation between the fields

$$\mathrm{curl}\mathbf{B}=\mathrm{curl}\mu\mathbf{H}=\frac{\mu k}{c}\frac{d\mathbf{E}}{dt}+4\pi\mu\mathbf{j}, \qquad (3)$$

by determining the space and time derivatives of $\mathbf{H}$ and $\mathbf{E}$, respectively, in terms of the motion of the charge q' producing both fields provides this relation no less rigorously than does the classical procedure of adding the fictitious concept of the displacement current. The similar useful relation of induced electric field in terms of space and time derivatives of $\mathbf{E}$ and $\mathbf{H}$, for

[2] For the case of the moving primary coil, the induced electric field in the stationary secondary coil, $\mathbf{E}_i=-\partial\mathbf{A}/c\partial t$, has the same value and is a component of the force per unit charge $\mathbf{v}\times\mathbf{B}/c$ as computed by the observer moving with the primary, even if one dislikes to use the term induced electric field for the case of the moving secondary.

example,

$$\text{curl}\mathbf{E} = -\frac{\mu}{c}\frac{d\mathbf{H}}{dt} = -\frac{1}{c}\frac{d\mathbf{B}}{dt}, \quad (4)$$

has not required the concept of a fictitious current density of magnetic poles where there were no poles passing through the points at which $d\mathbf{H}/dt$ was computed. The more detailed method of developing Eq. (3) in terms of the motion of q' shows also the conditions under which either the time rate of change of induced electric field is neglected or curlH is arbitrarily extended, an item usually obscured in the emphasis on displacement current. The method shows further that in the contribution of the induced electric field $\mathbf{E}_i$ to the space derivatives of $\mathbf{E}$ the leading terms in curl$\mathbf{E}_i$ are of the same order of magnitude as certain terms in div$\mathbf{E}_i$ which are omitted in writing div$\mathbf{E}=4\pi\rho$ in the usual classical development of Maxwell's equations.

A DIRECT DEVELOPMENT OF ELECTROMAGNETIC EQUATIONS

Using the classical expressions for the scalar and vector potentials in terms of steadily moving charges,

$$\phi = \Sigma e'/r, \quad \mathbf{A} = \Sigma e'\mathbf{v}'/cr, \quad (5a)$$

one finds at once the corresponding expressions for the electric and magnetic fields, **E** and **H**,

$$\mathbf{E} = \mathbf{E}_s + \mathbf{E}_i = -\nabla\phi - \frac{1}{c}\frac{\partial \mathbf{A}}{\partial t}$$

$$= \Sigma[e'\mathbf{r}/r^3 - e'\mathbf{f}'/c^2r - e'\mathbf{v}'(\mathbf{v}'\cdot\mathbf{r})/c^2r^3] \quad (5b)$$

$$\mathbf{H} = \text{curl}\mathbf{A} = \Sigma e'\mathbf{v}'\times\mathbf{r}/cr^3, \quad (5c)$$

since the acceleration of e' is $\mathbf{f}'$ and $\partial r/\partial t = -(\mathbf{v}'\cdot\mathbf{r})/r$. Equations (5) are only one set of many which satisfy the experimental results for closed circuits, and the lack of reciprocity in the classical Lorentz magnetic force using Eq. (5c) in $\mathbf{F}=(e\mathbf{v}/c)\times\mathbf{H}$ indicates that the equations in this set are incomplete, i.e., **H** does not represent all the force on the moving charge $e(v/c)$.

Equations (5b) and (5c), of course, satisfy Eq. (4) for the induced electromotance (emf) in a closed circuit, as may be seen directly when one takes the space derivatives of Eq. (5b) and the time derivative of Eq. (5c),

$$\text{div}\mathbf{E} = \Sigma[0 + e'(\mathbf{f}'\cdot\mathbf{r})/c^2r^3 + 3e'(\mathbf{v}'\cdot\mathbf{r})^2/c^2r^5 - e'v'^2/c^2r^3], \quad (6a)$$

$$\text{curl}\mathbf{E} = \Sigma[0 - e'(\mathbf{f}'\times\mathbf{r})/c^2r^3 - 3e'(\mathbf{v}'\times\mathbf{r})(\mathbf{v}'\cdot\mathbf{r})/c^2r^5] \quad (6b)$$

$$-\frac{1}{c}\frac{\partial \mathbf{H}}{\partial t} = \Sigma[-e'(\mathbf{f}'\times\mathbf{r})/c^2r^3 - 3e'(\mathbf{v}'\times\mathbf{r})(\mathbf{v}'\cdot\mathbf{r})/c^2r^5]. \quad (6c)$$

By taking also the space derivatives of Eq. (5c) and the time derivative of Eq. (5b),

$$\text{div}\mathbf{H} = 0, \quad (7a)$$

$$\text{curl}\mathbf{H} = \Sigma[3e'\mathbf{r}(\mathbf{v}'\cdot\mathbf{r})/cr^5 - e'\mathbf{v}'/cr^3], \quad (7b)$$

$$\frac{1}{c}\frac{\partial \mathbf{E}}{\partial t} = \Sigma[3e'\mathbf{r}(\mathbf{v}'\cdot\mathbf{r})/cr^5 - e'\mathbf{v}'/cr^3] + \Sigma[e'\mathbf{v}'v'^2/c^3r^3 - 3e'\mathbf{v}'(\mathbf{v}'\cdot\mathbf{r})^2/c^3r^5 - e'\mathbf{v}'(\mathbf{f}'\cdot\mathbf{r})/c^3r^3 - 2e'\mathbf{f}'(\mathbf{v}'\cdot\mathbf{r})/c^3r^3 - e'(d\mathbf{f}'/dt)/c^3r], \quad (7c)$$

we see that when one neglects the terms in $1/c^3$ which arise from the induced electric field $\mathbf{E}_i$, Eq. (7bc) is equal to Eq. (3) in free space and is the mathematical result of the form of the equations chosen to describe the fields, **E**, and **H**.

If one neglects terms in $1/c^3$, or (preferably) assumes that **E** in Eq. (7bc) includes induced electric field and hence that curlH in Eq. (7b) is to be extended to include terms in $1/c^3$, the propagation equation in **E** in the space between charges is obtained immediately by taking the curl of Eq. (6bc) and the time derivative of Eq. (7bc) (extended preferably to c^{-3} terms),

$$\text{curl}^2\mathbf{E} = \nabla\,\text{div}\mathbf{E} - \nabla^2\mathbf{E} = -\frac{1}{c}\frac{\partial}{\partial t}\text{curl}\mathbf{H} = -\frac{1}{c^2}\frac{\partial^2\mathbf{E}}{\partial t^2}. \quad (8)$$

This becomes the wave equation in **E** provided it can be shown that the gradient of Eq. (6a) is zero,

$$\nabla\,\text{div}\mathbf{E} = 0. \quad (9)$$

An easy way to guarantee the condition of Eq. (9) is to assume that div**E** = 0 in Eq. (6a), the procedure adopted in Maxwell's theory for electric waves in free space. The introduction of terms, resulting from this assumption, which compensate for the contribution of induced electric field to divE is discussed in more detail in connection with Hertz's solution below.

Continuing the development in terms of stationary and moving charges, we find in the usual way the values of divE in a body of charge density ρ and curl**H** in a wire carrying moving charges with mean current density j'. If n' is the number of conduction charges e' per unit length in any cross section ΔS, $n'e'v'/c=\Delta i'$. Then $H=\Delta i'\int dz\sin\theta/(r^2+z^2)$; and

$$\text{curl}\mathbf{H}=\lim_{\Delta S\to 0}\frac{\oint \mathbf{H}\cdot d\mathbf{l}}{\Delta S}$$

$$=\frac{\Delta \mathrm{i}'}{\Delta S}\int_0^{2\pi r}\int_{-\infty}^{\infty}\frac{rdzdl}{(r^2+z^2)^{\frac{3}{2}}}=\frac{4\pi\Delta \mathrm{i}'}{\Delta S}=4\pi \mathrm{j}'. \quad (10)$$

Extensions to include the permeability μ and the dielectric constant k are made as usual by restricting e' and i' to conduction charges and currents, so that the net (conduction and polarization) charge becomes $e'+e_p'=e'/k$, and the total (conduction and Amperian) current becomes $i'+i_m'=\mu i'$. Thus, Eq. (7bc) and Eq. (10) are represented by Eq. (3) as extended to include $\mathbf{E}_i$ and terms in $1/c^2$ in both curlB and $\partial \mathrm{E}/\partial t$. Also Eq. (4) must likewise now include $\mathbf{E}_i$, while

$$\text{div}\mathbf{E}=4\pi\rho/k, \quad (11)$$

provided one makes the remaining terms (in div$\mathbf{E}_i$) vanish in Eq. (6a). Equations (3), (4), and (11) as thus extended and restricted then yield the propagation equation in **E** in dielectric and magnetic media.

The somewhat unsatisfactory logic of the arbitrary extension of curl$\mathbf{H}=\partial \mathrm{E}/c\partial t$ to include induced electric field $\mathbf{E}_i$ may be avoided by a method used in the next paragraphs in dealing with another case of redundancy of concepts. The extension of div$\mathbf{E}_s=4\pi\rho/k$ to include the radiation part of $\mathbf{E}_i$ is retained however to provide a restriction justified on a different basis while leaving the equations in the Maxwell form.

The concept that both the fields **E** and **H**, and the potentials ϕ and **A** are propagated with speed $v=c/(\mu k)^{\frac{1}{2}}$ is redundant and unnecessary. Propagation of potentials alone is sufficient and represents more directly the transfer of energy by radiation. What meaning can be associated with the wave propagation of **E** save the ability to give a charge e an acceleration when the "**E**-wave" reaches e? Field **E** as a "moving force" on e has no meaning until it reaches e. The ability to exert force on e when arriving at e after the propagation time is an attribute of the propagated potentials, hence it is unnecessary to insist on any accompanying **E** wave. Economy and clarity of concept are thus provided by treating the propagation of potentials only, and finding **E** and **H** at the desired place and time by taking the appropriate space and time rates of change of the potentials. Both ϕ and **A** may be regarded as expressing the aggregate energy transferable to a statcoulomb of electrons e, whether the energy be transferred in a manner best described by quanta or by wave motion or both. There is very little exact direct experimental evidence for the magnetic field accompanying the electric field as such, and much more direct evidence for propagation of electrical energy. Assuming the equations of propagation of potentials

$$\nabla^2\phi-(1/v^2)\partial^2\phi/\partial t^2=C, \quad (12)$$

$$\nabla^2\mathbf{A}-(1/v^2)\partial^2\mathbf{A}/\partial t^2=\mathbf{K}, \quad (13)$$

determining $C=-4\pi\rho/k$ and $\mathbf{K}=-4\pi\mu\mathbf{j}$ from the steady-state conditions, and deriving the relations between the potentials and between the fields, Eqs. (14) and (15) below, provide the set of Maxwell equations quite as rigorously and with no more assumptions than does the conventional procedure of deriving Eqs. (12), (13). The experimental evidence more directly supports the assumptions made, while the "displacement current" recedes into the background. Equation (3) becomes simply a derived relation, Eq. (15), between the fields. This procedure uses $\mathbf{E}_s$ of Eq. (5b) in Eq. (11). Then comparison with Eq. (12),

$$-\text{div}\mathbf{E}=\nabla^2\phi+\frac{1}{c}\frac{\partial}{\partial t}\text{div}\mathbf{A}=-4\pi\rho/k=\nabla^2\phi-\frac{1}{v^2}\frac{\partial^2\phi}{\partial t^2},$$

results in the condition relating the potentials,

$$\text{div}\mathbf{A}=-\frac{c}{v^2}\frac{\partial\phi}{\partial t}=-\frac{\mu k}{c}\frac{\partial\phi}{\partial t}, \quad (14)$$

the last step, identifying $v=c/(\mu k)^{\frac{1}{2}}$, obtained from the steady-state boundary condition by taking space and time derivatives of Eqs. (5a) including k and μ explicitly. Next combining Eq. (5b) with Eq. (13) results in

$$\nabla^2\mathbf{A}=\nabla\,\mathrm{div}\mathbf{A}-\mathrm{curl}^2\mathbf{A}=\frac{\mu k}{c^2}\frac{\partial^2\mathbf{A}}{\partial t^2}-4\pi\mu\mathbf{j}$$

$$=-\frac{\mu k}{c}\nabla\frac{\partial\phi}{\partial t}-\frac{\mu k}{c}\frac{\partial\mathbf{E}}{\partial t}-4\pi\mu\mathbf{j},$$

and adding the condition, Eq. (14), yields the condition, [Eq. (3)],

$$\mathrm{curl}^2\mathbf{A}=\mathrm{curl}\mu\mathbf{H}=\frac{\mu k}{c}\frac{\partial\mathbf{E}}{\partial t}+4\pi\mu\mathbf{j} \qquad (15)$$

between the fields, without any need for calling $k(\partial\mathrm{E}/\partial t)/4\pi c$ a displacement current density. The development of Eqs. (14) and (15) from Eqs. (12) and (13), adds the single concept of propagation assumed in Eqs. (12) and (13), to replace the two usual assumptions, $\mathrm{curl}\mu\mathbf{H}=(\mu k/c)\partial\mathrm{E}/\partial t$, Eq. (3–15), considered either as a physical displacement current or as a mathematical term added to satisfy the continuity equation, and $\mathrm{div}\mathbf{A}=-(\mu k/c)\partial\phi/\partial t$, Eq. (14), the additional assumed relation between the potentials. Equation (14) now appears as merely a relation between the potentials which is a consequence of the form these potentials take, whether propagated or stationary. Equation (3–15) now appears likewise as simply a relation between the fields which is unchanged by the equations of propagation. Field $\mathbf{E}$ includes the electrostatic field $\mathbf{E}_s$ and the part of the induced electric field $\mathbf{E}_i$ effective in radiation. It permits the distinction between Eq. (15) for the radiation part of $\mathbf{E}_i$ and Eq. (7bc) for the quasi-stationary $\mathbf{E}_i$.

It is apparent that the use of $\mathrm{div}\mathbf{E}=4\pi\rho/k$, neglecting terms in $1/c^2$ in Eq. (6a), which are of the same order of magnitude as those needed and used in Eqs. (6bc) and (5b), is a restriction on the propagated field $\mathbf{E}$ which is not present in the induced electric field expressed as negative time rate of change of vector potential $\mathbf{A}=e'\mathbf{v}'/cr$. Furthermore, it is clear that it is this restriction and the neglect of the terms $\mathbf{f}'\cdot\mathbf{r}/c^2$, $\mathbf{v}'\cdot\mathbf{r}/c$, which insure that the components of velocity $\mathbf{v}'$ and acceleration $\mathbf{f}'$ parallel to the direction of propagation are ineffective. To demonstrate the point one need only show that a potential term not present in the forms of ϕ_s and $\mathbf{A}$, is introduced by use of $\mathrm{div}\mathbf{E}=4\pi\rho/k$, and that this added potential term yields directly terms in $\mathbf{E}$ which cancel these terms in $\mathbf{E}_i$. This cancellation of the terms in $\mathbf{f}'\cdot\mathbf{r}$ and $\mathbf{v}'\cdot\mathbf{r}$ is the process by which the insistence of their neglect in writing $\mathrm{div}\mathbf{E}=4\pi\rho/k$ is satisfied. For example the well-known Hertz solution[3] of Eqs. (12) and (13) for an oscillating electric dipole is obtained by use of spherical coordinates with axes oriented so that the vector potential of a moving charge is A_z and thus depends only on r. A solution of Eq. (13) is then found in the form $rA_z=f(t-r/c)$, a function of r and t only. When boundary conditions are added the solution becomes $A_z=\dot{p}(t-r/c)/cr$, where p, the electric moment of the dipole, is a "retarded" function of $(t-r/c)$, while r is not considered a function of t. Substituting this in Eq. (14) (which is the direct result of the neglect of terms in $\mathrm{div}\mathbf{E}_i$ by setting $\mathrm{div}\mathbf{E}=4\pi\rho$) and then integrating for ϕ, one obtains $\phi=\phi_s+\phi_2$ with a new scalar potential $\phi_2=\dot{p}(t-r/c)\cos\theta/cr=A_z\cos\theta$ in addition to the extended electrostatic potential $\phi_s=p(t-r/c)\cos\theta/r^2$. The radial component of the gradient of this added potential

$$(E_2)_r=-\partial\phi_2/\partial r=[\ddot{p}(t-r/c)\cos\theta/c^2r+\dot{p}(t-r/c)\cos\theta/cr^2], \qquad (16)$$

compensates the radial component of the induced electric field,

$$(E_i)_r=-\ddot{p}(t-r/c)\cos\theta/c^2r, \qquad (17)$$

i.e., the $\mathbf{f}'\cdot\mathbf{r}$ term. Also, $\mathrm{div}\mathbf{E}_2=-\mathrm{div}(\mathbf{E}_s+\mathbf{E}_i)$ cancels both the $\mathbf{v}'\cdot\mathbf{r}$ term, $2\dot{p}\cos\theta/cr^3$, and the $\mathbf{f}'\cdot\mathbf{r}$ term, $-\ddot{p}\cos\theta/c^2r^2$, in $\mathrm{div}(\mathbf{E}_s+\mathbf{E}_i)$ when they are expressed as functions of $t-r/c$.

Terms in v'^2/c^2 are neglected in the classical magnetic force of one moving charge $e'(\mathbf{v}')$ acting on another charge $e(\mathbf{v})$. It is interesting that this factor appears in $\mathrm{div}\mathbf{E}_i$, in use of $\partial r/\partial t=-\mathbf{v}'\cdot\mathbf{r}/r$, only to be neglected again in the classical dipole radiation.

As we have seen, the transverse nature of $\mathbf{E}$ in the radiation zone is assured formally by retaining $\mathrm{div}\mathbf{E}=4\pi\rho$ without a physical reason therefor. The physical reason is supplied by ballistic theory which accounts for $\mathbf{v}'\cdot\mathbf{r}=0$ and

[3] Abraham-Becker, *Classical Electricity and Magnetism* (Blackie and Son, London, 1932), p. 223.

r=0 due to mix-up-in-phase[4] the propagated rticles (or influence) separating from the ctron-proton dipole source with speed c, hav- g velocity $c+v_r'$ ahead of the electron e' and locity $c-v_r'$ behind it and not arriving at e th simple harmonic impulses. Thus, we see at closer study of details, including now bal- tic theory which accounts for electromagnetic opagation,[5] can account also for the great ccess which the classical approximation, lead- g to Maxwell's theory, has experienced.

COMPARISON WITH CLASSICAL THEORY

Let us see now how closely Maxwell's formula- on of his theory in terms of displacement cur- nt corresponds to the steps (5abc), (6abc), abc), (8), (9), (10), (11) in terms of motion charges. Maxwell[6] stressed electric polariza- on as consisting of electric charge Q displaced ross the dielectric within a condenser, in re- onse to an equal conduction charge trans- rred by the applied electromotance along the ternal wire, such that the surface density of is displacement charge Q is $D=kE/4\pi$. He d not clearly distinguish this from the physi- l polarization charge density $P=D-E/4\pi$ $(k-1)E/4\pi$ due to charges displaced within e atoms and which is equivalent to net charge r unit area displaced across the dielectric, nor d he note that P approaches D only for the nductor ($k=\infty$, $E=0$), and that P approaches ro for vacuum. In Sec. 111, Maxwell asserted at "according to [his] theory all charge is the sidual effect of the polarization of the dielec- ic." It is evident, as Jeans recognized,[7] that axwell's displacement of charge cannot be dinary charge and that Maxwell's concept ecomes unnecessary for the development of the eory. Yet Jeans and others use Maxwell's otal current," $[j'+(k/4\pi c)(dE/dt)]dS$.

The development of classical electromagnetic eory, as exemplified by Maxwell and Jeans, sts its case on the use of the Lorentz force, $\mathbf{v}/c)\times e'\mathbf{v}'\times\mathbf{r}/cr^3$; and success of classical the- ory despite its drawbacks is usually considered to justify use of this nonreciprocal force formula for moving charges. This formula was developed for the action on an electron by a magnet, now believed to consist of closed Amperian currents due to electrons rotating and spinning in closed paths, and has been verified for the action of a closed primary current on a moving electron, but not for an unclosed primary current.[8] The relations $\oint \mathbf{H}\cdot d\mathbf{l}=4\pi i'$ and $\text{curl}\mathbf{H}=4\pi\mathbf{j}'$ are valid with current traversing a closed path and with current density $\mathbf{j}'$ uniform over a small volume not near the ends of a uniform current. As these formulas have not been verified for unclosed primary currents, it is to be expected that they should yield $\text{div}\,\text{curl}\mathbf{H}=0=4\pi\,\text{div}\mathbf{j}'$ as they do, characteristic of a current following a closed path. Circuits ending on condenser plates are thus not completely described by these classical relations. Instead of taking this result as an additional indication of the inadequacy of $\mathbf{H}$ and the incompleteness of $e\mathbf{v}\times\mathbf{H}/c$ for $\mathbf{H}$ produced by charges moving in unclosed paths, Maxwell and his followers chose to emphasize the etherial displacement current. The time rate of change of an electric field between condenser plates was assigned the concept of a current and added to the conduction current to form Maxwell's "total current," which satisfies the equation of continuity and $\text{div}\,\text{curl}\mathbf{H}=\text{div}(4\pi\mathbf{j}'+k\dot{\mathbf{E}}/c)=0$, and results in Eq. (3) which corresponds to Eqs. (7bc), (10). The use of the nonreciprocal force $(e\mathbf{v}/c)\times e'\mathbf{v}'\times\mathbf{r}/cr^3$, which becomes equal to the reciprocal force for a closed circuit in $e'\mathbf{v}'$ acting on a moving charge $e\mathbf{v}$, was formally justified by the belief that "all circuits are closed." But the question of the contribution of each electron $e'\mathbf{v}'$ in the primary circuit to the magnetic force on the electron $e\mathbf{v}$, was left unanswered. Only the expression for the total force on $e\mathbf{v}$ due to the whole closed primary circuit was justified.[8] And scientists, ever ready to embrace a new concept, evidently failed to remark that Eq. (3) expresses the relation be-

[4] F. W. Warburton, Phys. Rev. 69, 40 (1946).
[5] M. J. S. Dewar, Phil. Mag. 38, 488 (1947).
[6] J. C. Maxwell, *Treatise on Electricity and Magnetism* Clarendon Press, Oxford, 1940), third edition, Vol. 1, sec- ons 60, 75, 76, 111, Vol. 2, Sec. 608 ff.
[7] J. H. Jeans, *Electricity and Magnetism* (Cambridge Uni- ersity Press, Cambridge, 1923), pp. 155, 511.

[8] One cannot, of course, accept as proof of the validity of the Lorentz force any case in which any of the reciprocal formulas of the Ampere-Weber-Riemann type can also be used, for the Lorentz force is incompatible with these for unclosed circuits. Very definite proof of the superiority of the reciprocal forces is shown in Dunton's circuit breaker [Nature 140, 245 (1937)] and in Cleveland's rectangle [Phil. Mag. 21, 416 (1936)].

tween H and the rate of increase of electrostatic field of a moving charge, even if H should be inadequate or have no meaning at all.

We should note that the classical expression $\mathrm{div}(4\pi \mathbf{j}'+k\dot{\mathbf{E}}/c)=0$ developed in the usual way for the electrostatic field in a condenser in terms of current density $\mathbf{j}'$ omits variations in the induced electric field $\mathbf{E}_i$, just as does neglect of the c^3 terms in Eq. (7c). The extension of Eq. (3) to include the induced electric field in E, is then a pure assumption that the electrostatic field is inadequate to satisfy Eq. (3), and that the addition of the induced electric field is needed, this despite the fact that Eq. (3) was set up in terms of electrostatic field. And it is rarely made clear that Eq. (3) does not represent an accurate relation between the unextended $\mathbf{B}=\mathrm{curl}\mathbf{A}$ of quasi-stationary states, Eq. (7b), and the expanded E including $\mathbf{E}_i$, Eq. (7c).

Equations (11) and (9) substituted in Eq. (8), yield the wave equation in E. An additional assumption, Eq. (14), is needed for deriving the equations for propagation of the potentials ϕ and A. These steps represent the classical procedure whether $(k/4\pi c)(\partial \mathbf{E}/\partial t)$ is considered a physical displacement current or whether it is simply a term added to satisfy the continuity equation and to build up a self-consistent set of equations for the extended E. The former case suffers a bit more unsatisfactory logic than developing Eq. (8) from Eq. (6bc) and Eq. (7bc) which contains $1/c^3$ terms; while the latter case escapes this weak development only indirectly by assuming that the field E satisfying the Maxwell equations is the correct one, and hence that the quasi-stationary induced electric field, $\mathbf{E}_i=-\partial \mathbf{A}/c\partial t$ is incomplete or includes too much. The weak link then appears, in most presentations, in that the reader is not forewarned that the r component of $\mathbf{E}_i$ (Eq. 17) is not to be used even in low frequency ac and transient currents since it is compensated by the r component of $\mathbf{E}_2$, (Eq. 16). As alternating and transient currents are made up of oscillating dipoles, literal acceptance of the extended E of the Maxwell equations as the only correct E requires the cancellation of the accelerational $\ddot{p}$ term $(E_i)_r$ in Eqs. (16), (17), even near the source where $r \ll ct$. On the other hand the fact that quasi-stationary states are ordinarily satisfactorily described in terms of $d\mathbf{A}/dt$ without mention of the cancellation of $(E_i)_r$ by $\partial\phi_2/\partial r$ indicates that $\mathbf{E}_i$ is not necessarily thus restricted in dealling with alternating and oscillating primary currents.

In each of the two forms of classical theory mentioned above emphasis is placed on the formal extension of divE to include $\mathbf{E}_i$, without apparent recognition that this supports the prediction of the reciprocal theories[4,5] that the r component of the induced electric field $\mathbf{E}_i$ used in quasi-stationary states need not be effective in the radiation zone. In other words the (partial) success of the Maxwell theory, which includes the nonreciprocal Lorentz force and the arbitrary extension of E used in Eq. (3) and Eq. (11), should not be construed as evidence against the nonlocalized reciprocal ballistic theories which can describe radiation also by assumption of propagation of potentials:

SUMMARY

The concept of a displacement current where there is no flow of charge, although it appeared useful at the time it was invented, was soon found unnecessary. The approximate relation $\mathrm{curl}\mathbf{B}/\mu=k\dot{\mathbf{E}}/c$ is a consequence of the form of the equations representing H and E. This relation is assumed exact when H and E are extended to include propagation in the classical development of the retarded fields and potentials. This relation is found unchanged but becomes of secondary importance when assuming propagation and deriving the relations between the potentials and between the fields. In both methods the theory gains noticeably in consistency when such an extraneous concept as displacement current is eliminated from this relation of B and $d\mathbf{E}/dt$. The concept of displacement current is a handicap because it takes attention off the retarded action of charge on charge and the conditions which guarantee the transverse electric field in the radiation zone. Details suggestive of ballistic emission, which are ordinarily ignored in classical theory, become evident when emphasis is taken off the smoothed-over field theory and more attention is placed on the action of charge e' on charge e (after the propagation time) in terms of which the potentials and the fields are defined.

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Displacement Currents and Magnetic Fields

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The methods of calculating fields due to quasi-steady currents in closed and unclosed circuits are reviewed. It is emphasized that it is sufficient to apply the Biot–Savart law to all the moving charges and to ignore the vacuum displacement current. Attention is drawn to a basic error in the widespread practice of treating a circuit containing a capacitor as though the fringing fields could be ignored and the displacement current replaced by conduction currents confined to the gap between the plates.

1. INTRODUCTION

SURPRISINGLY many textbooks of physics contain misleading or erroneous statements about the magnetic effect of electric displacement currents. To focus attention on the type of misconception that is involved, let us consider the following problem: Suppose that we charge two parallel conducting plates so that they carry equal charges of opposite sign; between them there is an electric field. Now imagine that we turn on a strong x-ray source and irradiate the air between the plates. The air in the gap becomes ionized and the ions move, carrying electric charges from one plate to the other, thereby discharging the plates. What is the magnetic field at a point, say P, outside the plates? (Fig. 1)

Certainly the movement of the ions produces a magnetic field at P. It is sometimes argued that, in addition, as the plates are discharged, the changing electric field between the plates, that is, the displacement current, produces a magnetic field at P which is equal and opposite to that produced by the movement of the ions; it is thus predicted that the resultant magnetic field is zero. This is incorrect. The movement of the ions produces a magnetic field at P, and that *is* the field. It is not canceled or diminished by anything else.[1] Planck expressed this clearly many years ago when he wrote,[2] ". . . even in the case of unclosed currents the magnetic intensity of the field is calculated from the vector-potential of the conduction currents without regard to the displacement currents. . . ." (Planck is here dealing with situations for which ϵ is the same everywhere.)

We will return to this "leaky capacitor" problem later, but first let us examine more generally the role of the displacement current in such problems.

2. CALCULATING THE MAGNETIC FIELD

There are several equivalent methods by which the magnetic field can be calculated. For quasi-steady conditions, that is, ignoring radiation effects, B can be calculated, using the Biot–Savart law, from a knowledge of the *real currents alone*:

$$\mathbf{B}(\mathbf{r})=\frac{\mu_0}{4\pi}\int\frac{\mathbf{J}(\mathbf{r}')\times(\mathbf{r}-\mathbf{r}')d\tau'}{|\mathbf{r}-\mathbf{r}'|^3}. \qquad (1)$$

This is one method.

A second method is to use the Maxwell equation

$$\text{curl }\mathbf{B}=\mu_0(\mathbf{J}+\dot{\mathbf{D}}). \qquad (2)$$

This equation can be obtained by taking the curl of Eq. (1), provided that quasi-steady conditions are assumed.[3] If Eq. (2) is integrated over a Stokes surface bounded by some closed contour, we have the familiar result

$$\oint\mathbf{B}\cdot d\mathbf{l}=\mu_0\int_S(\mathbf{J}+\dot{\mathbf{D}})\cdot d\mathbf{S}. \qquad (3)$$

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[1] Any conduction currents which flow in the plates, of course, also contribute to the magnetic field.

[2] Max Planck, translated by H. L. Brose, *Introduction to Theoretical Physics* (MacMillan and Company, Ltd., London, 1932), Vol. III, p. 197; see also W. T. Scott, *The Physics of Electricity and Magnetism* (John Wiley & Sons, Inc., New York, 1959), p. 304.

[3] See, for example, Arthur Bierman, Am. J. Phys. 29, 355 (1961); J. D. Jackson, *Classical Electrodynamics* (John Wiley & Sons, Inc., New York, 1962), Secs. 5.3, 6.3.

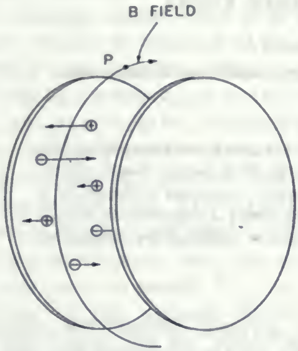

FIG. 1. Magnetic field surrounding the "leaky capacitor."

This integrated form then allows one to make the statement that the line integral of **B** around a closed loop is equal to the total flux of real current plus displacement current through the loop. We have here what we may call the generalized form of Ampère's circuital theorem. In this way of stating the result, the inclusion of the displacment current is essential for obtaining correct answers.

It may be instructive to illustrate the equivalence of these two methods with the following specific and basic example: Consider a current I flowing over an infinitesimal line segment ds (Fig. 2) with accumulation of charges $-q$ and $+q$ at the ends of the element.

Let us calculate, by means of the circuital theorem, the magnetic field at a point P, whose coordinates are (r,ϑ) with respect to one end of the element. Given the obvious symmetry of the problem, we choose as the boundary line l of our integration a circle through P, of radius $r\sin\vartheta$, with its center on the axis defined by ds. The surface of integration on the right-hand side of Eq. (3) can be any surface bounded by the contour.

Suppose, first, that we take a surface S that does not intersect the current element. Then the **J** term in Eq. (3) vanishes, and, ignoring retardation effects, we have,

$$\int_S \dot{\mathbf{D}}_{(+q)}\cdot d\mathbf{S} = \tfrac{1}{2}\dot{q}(1-\cos\vartheta)$$

$$\int_S \dot{\mathbf{D}}_{(-q)}\cdot d\mathbf{S} = -\tfrac{1}{2}\dot{q}[1-\cos(\vartheta+d\vartheta)].$$

Combining these, and using $d\vartheta = -ds\sin\vartheta/r$, we have

$$\int_S \dot{\mathbf{D}}\cdot d\mathbf{S} = \tfrac{1}{2}\dot{q}\sin^2\vartheta ds/r.$$

The circuital theorem then gives us

$$2\pi r\sin\vartheta B_l = (\mu_0\dot{q}/2)(\sin^2\vartheta ds/r),$$

that is

$$B_l = (\mu_0/4\pi)(I\sin\vartheta ds/r^2). \qquad (4)$$

This is at once recognized as the result obtained by applying the Biot–Savart law to the real current flowing in the segment ds.[4]

It can be easily verified that if we had used a surface S', intersecting the current element, the **J** and $\dot{\mathbf{D}}$ would have combined to give the same result.

The above example of the equivalence of Eqs. (1) and (3), though simple, is important, because any electrical circuit, whether it be closed or open, can be represented as a combination of such current elements. And the currents in successive elements can be different, thus allowing for the accumulation of charge at particular places in the circuit, as, for example, on the plates of a capacitor.

3. CIRCUITS WITH CAPACITORS

We consider now a parallel-plate capacitor being charged by a current I [Fig. 3(a)]. Let the capacitor have circular plates of radius R and separation d, and suppose that we wish to find the magnetic field at a point P, lying just outside the plates on the mid-plane between

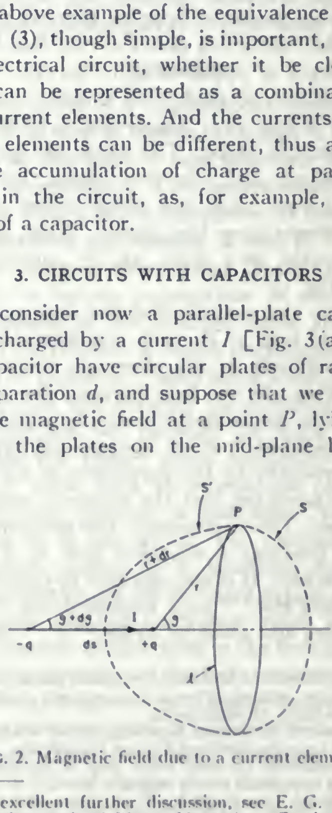

FIG. 2. Magnetic field due to a current element.

[4] For excellent further discussion, see E. G. Cullwick, *The Fundamentals of Electro-Magnetism* (Cambridge University Press, New York, 1949), pp. 149 ff.

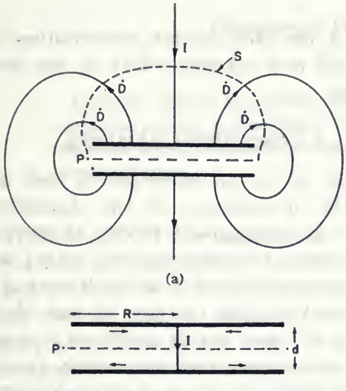

FIG. 3. (a) Capacitor with fringing fields, during charging; (b) current flow in internally shorted capacitor.

hem. The first feature to be noted is that the ield at P is certainly less than would be the case f the real current I were continued between he plates. For suppose we draw a Stokes surface S as shown, having as its boundary a circular oop through P with its center on the axis of ymmetry. This surface will be threaded in one lirection by the real current I, and in the oppoite direction by lines of $\dot{\mathbf{D}}$. If the capacitor plates vere shorted, without changing the size of I, he potential difference between them would become constant, and the lines of $\dot{\mathbf{D}}$ would lisappear. Thus the net flux of conduction plus lisplacement currents through the surface S, and ience the field $\mathbf{B}$, is less in the first case than in he second. But how much less? To say (as many extbooks do) that the difference is trivial, being lue merely to the small fringing fields, covers up a vital feature: the difference corresponds precisely to the missing part of the real-current ircuit.

A closely related situation is the internal discharge of a capacitor, and we believe that this example is of particular value in exposing the basis of some of the misconceptions regarding lisplacement current. In Fig. 3(b) we show our capacitor being discharged by a shorting wire between the plates. The general pattern of current flow is shown by the arrows. Again we consider a circular path through all points such is P, distant R (approximately) from the axis of symmetry, but this time we take our Stokes surface to be the plane of the circle. The circuital law tells us that

$$2\pi R B_l = \mu_0\left(I + \int_S \dot{\mathbf{D}}\cdot d\mathbf{S}\right),$$

where I is the total current flowing in the shorting wire. Hence

$$B_l = (\mu_0 I/2\pi R) + (\mu_0/2\pi R)\int_S \dot{\mathbf{D}}\cdot d\mathbf{S}. \qquad (5)$$

We thus have the magnetic field formally expressed as the algebraic sum of two terms: the field of an infinitely long wire carrying the current I, and the field due to an oppositely directed flow of displacement current. The usual elementary discussion of this result consists in saying that, *if fringing effects are ignored*, the two terms on the right-hand side of Eq. (5) are equal and opposite, and hence the external magnetic field is zero. This is a mistake in principle. It requires that the electric field be entirely confined to the region between the plates; but this in turn requires reducing the gap between the plates to zero, thus eliminating the capacitor altogether. If we analyze the problem from the standpoint of the Biot–Savart law, then, as Fig. 3(b) shows, the real currents in the capacitor plates and the shorting wire will cooperate to give a nonvanishing field at P, and its value will be given approximately by

$$B_l \approx (\mu_0/4\pi)(Id/R^2). \qquad (6)$$

It is no surprise to discover that the actual field B_l, as given by Eq. (6), is of the order of d/R times the first term on the right-hand side of Eq. (5).

4. THE LEAKY CAPACITOR

We have discussed the two most familiar methods by which one can calculate the magnetic field in the neighborhood of a circuit containing a capacitor. The relationship between them can be further illuminated, and the importance of the fringing field emphasized, by the following considerations, which we will apply to the leaky capacitor problem with which we began this paper.

Equations (2) and (3) show clearly that the displacement current density $\dot{\mathbf{D}}$ is equivalent to

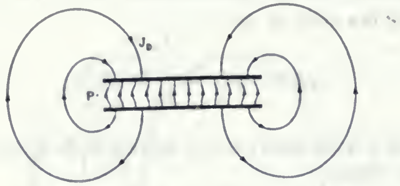

FIG. 4. Effective current distribution due to $\dot{\mathbf{D}}$ in discharge of leaky capacitor.

a real current density, say $\mathbf{J}_D$. Let us then replace $\dot{\mathbf{D}}$ everywhere with $\mathbf{J}_D$ (Fig. 4). We could, in principle, calculate the contribution of the current field $\mathbf{J}_D$ to the magnetic field at P using the Biot–Savart law, Eq. (1). The result is, however, zero; this means that the Biot–Savart contribution from that portion of $\mathbf{J}_D$ which lies "between" the plates is *exactly canceled* by the contribution from the fringing $\mathbf{J}_D$. One way of seeing that the $\mathbf{J}_D$ distribution produces no magnetic field is to recognize that B is given by[6]

$$\mathbf{B}(\mathbf{r}) = \frac{\mu_0}{4\pi}\int \frac{\operatorname{curl}\mathbf{J}(\mathbf{r}')}{|\mathbf{r}-\mathbf{r}'|}d\tau'.$$

Hence if $\mathbf{J}$ in this equation is $\mathbf{J}_D$, and thus expressible, for quasi-steady situations, as the gradient of a scalar, the curl of $\mathbf{J}$ is zero and the integral vanishes. This result is implicit in Planck's statement quoted earlier. Thus all that remains is the Biot–Savart contribution from the original real currents—that is, the motion of the ions.

[6] See, for example, S. J. Raff, Am. J. Phys. 26, 454 (1958).

5. CONCLUDING REMARKS

It is not at all our intention to seek to diminish the importance of the displacement current in electromagnetic theory. In particular, the treatment of electromagnetic waves would be absurdly complicated if the fields were always referred back to the motions of real charges. And even in many circuit problems it is much simpler to compute magnetic fields from the circuital theorem than from the Biot–Savart law.

We have, however, sought to make two main points. The first is to emphasize that, in all cases of quasi-steady currents, be they closed or unclosed, the magnetic field can be calculated by applying the Biot–Savart law to all the moving charges in the system. The second is that, in calculating by the alternative method of the circuital theorem, in which both conduction currents and displacement currents are included, one must be sure to avoid approximations that are basically incompatible with the special features of the system being investigated.

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Maxwell, Displacement Current, and Symmetry

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Maxwell's reasons for introducing displacment current are considered. His published works disclose no arguments based upon symmetry, but emphasis on the symmetry of Maxwell's equations with regard to electric and magnetic fields is found in Oliver Heaviside's work on electromagnetic theory.

MATHEMATICAL symmetry and beauty have become important considerations in twentieth century physics, both in creating new physical theories and in elegantly connecting symmetry with conservation laws. An early use of such considerations in developing a new theory is sometimes attributed to James Clerk Maxwell. Norman Campbell says[1]: "Suppose you found a page with the following marks on it—never mind if they mean anything [Maxwell's equations without displacement currents on the left, with displacement currents on the right]. I think you would see that the set of symbols on the right side are 'prettier' in some sense than those on the left; they are more symmetrical. Well, the great physicist, James Clerk Maxwell, about 1870, thought so too; and by substituting the symbols on the right side for those on the left, he founded modern physics and, among other practical results, made wireless telegraphy possible." Similar statements also occur in more recent sources.[2]

In the classroom it is customary to stress the symmetry of Maxwell's equations; one can even allow a class to "discover" the displacement current, as Campbell indicates that Maxwell did. But does this pedagogically useful device actually represent the historical reasoning in the introduction of the concept? The set of historically accurate events and the set of pedagogically useful material, while certainly possessing a nonempty intersection, are not identical sets. By now the physicist and the historian of science are painfully aware of the facile flowering of historical legends in the sciences. Our purpose here is to try to determine the historical events underlying Maxwell's introduction of displacement current. First, we see what Maxwell has to say concerning the displacement current, then we examine some of the secondary sources and, finally, we try to draw some conclusions.

THE THREE MAJOR PAPERS

Maxwell's work on electromagnetic field theory is published primarily in three major papers: "On Faraday's Lines of Force" (1855–1856), "On Physical Lines of Force" (1861–1862), and "A Dynamical Theory of the Electromagnetic Field" (1864). The papers show a progressive development of Maxwell's thought. The line of development has been reviewed by Whittaker[3] and Gillispie[4] so a brief summary suffices here.

As the title indicates, the first paper is based on Faraday's work, particularly its extension to mathematical structure. The second paper employs an elaborate mechanical model of rotating cells and contains all the essential mathematical results in twenty equations in twenty unknowns. The third paper is definitive—the model is abandoned, the equations are collected together (in Part III), and the term "electromagnetic field" is introduced.

Now we wish to determine what each of these papers says about the displacement-current term.[5] In I the displacement current does not appear. The "curl **H**" equations occur with only the conduction-current term on the right side of

* Written while a National Science Foundation Science Faculty Fellow at Harvard University.

[1] N. R. Campbell, *What Is Science?* (Methuen and Company, Ltd., London, 1921), pp. 155–156.

[2] E. Rogers, *Physics for the Inquiring Mind* (Princeton University Press, Princeton, New Jersey, 1960), p. 471.

[3] E. T. Whittaker, *A History of the Theories of Aether and Electricity* (Longmans Green and Company Ltd., London, 1910), 1st ed.

[4] C. C. Gillispie, *The Edge of Objectivity* (Princeton University Press, Princeton, New Jersey, 1960).

[5] For brevity the papers are called I, II, and III. Page numbers for the papers refer to *The Scientific Papers of James Clerk Maxwell*, edited by W. D. Niven (Cambridge University Press, Cambridge, England, 1890). Vol. I.

the three equations. (It should be noted that this name is used here only for convenience. Maxwell does not use this notation in I, II, or III.) Immediately after the equations, he says[6]: "We may observe that the above equations give by differentiation

$$da_1/dx+db_2/dy+dc_2/dz=0,$$

which is the equation of continuity for closed currents. Our investigations are, therefore, for the present, limited to closed currents; and we know little of the magnetic effects of any currents which are not closed." He then drops this and proceeds to other matters.

The displacement current occurs for the first time in II.[7] He refers to the displacement of electricity in each molecule because of an electric field applied to a dielectric, as measured by the electric displacement. "The effect of this action on the whole dielectric mass is to produce a general displacement of the electricity in a certain direction. This displacement does not amount to a current, because when it has attained a certain value it remains constant, but it is the commencement of a current, and its variations constitute currents in a positive or negative direction, according as the displacement is increasing or diminishing." A few pages later he uses this conclusion in Proposition XIV, "To correct the equations (9) of electric currents for the effect due to the elasticity of the medium . . . a variation of displacement is equivalent to a current, this current must be taken into account in equations (9) and added to [the conduction current]. . . ." Then he states the equation of continuity with time-derivative term.

As already indicated, III is in many ways a more polished and elegant version of II. Among the twenty equations of the electromagnetic field are those constructing the "true" currents by addition of the displacement currents and conduction currents. "Electrical displacement consists in the opposite electrification of the sides of a molecule or particle of a body which may or may not be accompanied with transmission through the body . . . the variations of the electrical displacement must be added to the currents p, q, r to get the total motion of electricity. . . ."[8] The equation of continuity is also one of the twenty equations, not deduced here from the others. It is worth noting that in III the curl **H** equations do not explicitly appear with a time derivative of displacement in the equations, for the equations of true currents are stated as separate equations; this is in contrast with II.

[6] Ref. 5, p. 191.

[7] Ref. 5, p. 491.

A TREATISE ON ELECTRICITY AND MAGNETISM

The *Treatise* appeared in three editions, 1873, 1881, and 1892. With regard to displacement current, all the editions are almost identical; Maxwell only revised the first part of the second edition. In general, the *Treatise* is similar in tone to III; the fundamental equations are gathered together in the second volume almost as in III. In the first volume, Maxwell already hints at the current in a discussion of electric displacement.[9] "When induction takes place in a dielectric, a phenomenon takes place which is equivalent to a displacement of electricity in the direction of the induction. . . . Any increase of this displacement is equivalent, during the time of increase, to a current of positive electricity from within outwards, and any diminution of the displacement is equivalent to a current in the opposite direction." Whittaker[10] appears to have overlooked this passage.

One new element does emerge in volume two; Maxwell states explicitly that the displacement current is a new contribution.[11] "One of the chief pecularities of this treatise is the doctrine which it asserts, that the true electric current C, that on which the electromagnetic phenomena depend, is not the same thing as R, the current of conduction, but that the time variation of D, the electric displacement, must be taken into account in estimating the total movement of electricity, so that we must write, $C=R+\dot{D}$ (Equation of True Currents). . . ." Just before this,[12] he has written the curl **H** equation with a current in it;

[8] Ref. 5, p. 554.

[9] J. C. Maxwell, *A Treatise on Electricity and Magnetism* (Oxford University Press, Oxford, England), Vol. I, 1st ed., (1873), p. 132; 2nd ed. (1881), p. 154; 3rd ed. (1892), p. 166. The second and third editions use slightly different terminology.

[10] E. T. Whittaker, Ref. 3, p. 300.

[11] J. C. Maxwell, Ref. 9, II, 1st ed., p. 232; 2nd ed., p. 234.

[12] Ref. 9, 1st ed., p. 231; 2nd ed., p. 233.

he points out that this implies zero divergence for the current and so closed circuits. "This equation is true only if we take u, v, and w as the components of that electric flow which is due to the variation of electric displacement as well as to true conduction." He continues, "We have very little experimental evidence relating to the direct electromagnetic action of currents due to the variation of electric displacement in dielectrics, but the extreme difficulty of reconciling the laws of electromagnetism with the existence of electric currents which are not closed is one reason among many why we must admit the existence of transient currents due to the variation of displacement. Their importance will be seen when we come to the electromagnetic theory of light."

MAXWELL'S OTHER PAPERS AND LETTERS

In the second part of a short paper, "On a Method of Making a Direct Comparison of Electrostatic with Electromagnetic Force; with a Note on the Electromagnetic Theory of Light," Maxwell reviews the electromagnetic theory of light in order to differentiate his approach from those of Riemann, Weber, and Lorenz.[13] After stating three theorems, he says: "When a dielectric is acted on by electromotive force it experiences what we may call electric polarization. If the direction of the electromotive force is called positive, and if we suppose the dielectric bounded by two conductors, A on the negative and B on the positive side, then the surface of the conductor A is positively electrified, and that of B negatively . . . ." Then, "Theorem D—when the electric displacement increases or diminishes, the effect is equivalent to that of an electric current in the positive or negative direction. Thus, if the two conductors in the last case are now joined by a wire, there will be a current in the wire from A to B. . . . According to this view, the current produced in discharging a condenser is a complete circuit, and might be traced within the dielectric itself by a galvanometer properly constructed. I am not aware that this has been done, so that this part of the theory, though a natural consequence of the former, has not been verified by direct experiment. The experiment would certainly be a very delicate and difficult one." Whereupon Maxwell deduces the plane electromagnetic waves from these assumptions without writing down the field equations in their general form.

We should remember one other paper, the "Address to the Mathematical and Physical Section of the British Association," given on 15 September 1870. Here, finally, we do find Maxwell mentioning questions of mathematical symmetry. Because of its importance to the present investigation, and because of the general interest in the topic, a part[14] is quoted at length.

"The student who wishes to master any particular science must make himself familiar with the various kinds of quantities which belong to that science. When he understands all the relations between these quantities, he regards them as forming a connected system, and he classes the whole system of quantities together as belonging to that particular science. This classification is the most natural from a physical point of view, and it is generally the first in order of time.

"But when the student has become acquainted with several different sciences, he finds that the mathematical processes and trains of reasoning in one science resemble those in another so much that his knowledge of the one science may be made a most useful help in the study of the other.

"When he examines into the reason of this, he finds that in the two sciences he has been dealing with systems of quantities, in which the mathematical forms of the relations of the quantities are the same in both systems, though the physical nature of the quantities may be utterly different.

"He is thus led to recognize a classification of quantities on a new principle, according to which the physical nature of the quantity is subordinated to its mathematical form. This is the point of view which is characteristic of the mathematician; but it stands second to the physical aspect in order of time, because the human mind, in order to conceive of different kinds of quantities, must have them presented to it by nature."

But there is no explicit reference to displacement current, and Maxwell only cites examples from the work of others. The cases which come to mind from reading the previous statement are

[13] Ref. 5, II, 139. Originally published in Phil. Trans. Royal Soc. London, 158 (1868).

[14] Ref. 5, p. 218. British Association Report, 40 (1870).

(1) the analogy between heat conduction and static electricity pointed out by W. Thomson, and (2) the general analogy between hydrodynamics and electromagnetic field, mentioned by Maxwell at the beginning of I.

There appears to be no systematic collection of Maxwell's letters. Some letters are in the biography of Campbell and Garnett.[15] The important letters to W. Thomson have been printed in a separate volume.[16] An often quoted letter to Thomson describes the 1861 paper, but does not mention displacement current by name. It does say: "Thus there will be a displacement of particles porportional to the electromotive force, and when this force is removed the particles will recover from displacement." Published letters to G. G. Stokes[17] and P. G. Tait[18] contribute nothing to a knowledge of displacement current. Finally, Maxwell's poetry[19] contains no references.

SECONDARY SOURCES

Maxwell's work on electromagnetic theory, like Newton's on mechanics, did not win immediate acceptance even in England. The three major papers appear to have gained little attention, and only after the *Treatise* did the theory find supporters. Most of Maxwell's close friends failed to appreciate it. W. Thomson maintained lifelong reservations about the theory as a whole, and about displacement currents in particular. P. G. Tait, the other half of the famous "*T* and *T′*," wrote both the unsigned review of the *Treatise* and an evaluation of Maxwell's work after his death.[20,21] The review is highly favorable, comparing Maxwell with Newton; but whereas he listed nine points particularly worthy of note (including the mention of quaternions!) he omitted mention of displacement current. This omission together with the evaluation leads one to believe that Tait did not fully understand the new theory. Reviews in the *Quarterly Journal of Science* and *American Journal of Science and Arts* do not mention displacement current either. As would be expected, the English scientists who accepted Maxwell were very much influenced by his treatment. Watson and Burbury[22] make the same arguments concerning the polarization of the dielectric medium that we have seen in the original form.

Oliver Heaviside is the first physicist who, insofar as the present writer is aware, explicitly refers to the symmetry of Maxwell's equations. In the delightful preface to *Electromagnetic Theory*[23] he mentions his outline of "electromagnetic theory from the Faraday–Maxwell point of view, with some small modifications and extensions upon Maxwell's equations." He suggests three modifications: First, he uses rationalized units; second, he uses vector notation similar to contemporary notation, with "curl," "div," and boldface (Clarendon) type; and third, "it is done in the duplex form I introduced in 1885, whereby the electric and magnetic sides of electromagnetism are symmetrically exhibited and connected. . ." It is clear that he regards the "duplex form" as an important innovation not appearing in Maxwell's papers and books. Both in his earlier paper, "Electromagnetic Induction and its Propagation"[24] and in *Electromagnetic Theory* he uses this symmetry. In the former, for example, he writes the two curl equations one after the other, noting that "We must change magnetic force to electric force taken negatively, and electric current to magnetic current," current being used in the Maxwellian sense of including the time-derivative terms. There is a suggestion[25] that the displacement current makes this form possible: "The electric current in a nonconductor was the very thing wanted to coordinate electrostatics and electrokinetics, and consistently harmonize

[15] L. Campbell and W. Garnett, *The Life of James Clerk Maxwell* (MacMillan and Company Ltd., London, 1882).

[16] *Origins of Clerk Maxwell's Electric Ideas as Described in Familiar Letters to William Thomson*, edited by J. Larmor (Cambridge University Press, Cambridge, England, 1937).

[17] *Memoir and Scientific Correspondence of the Late Sir George Gabriel Stokes*, edited by J. Larmor (Cambridge University Press, Cambridge, England, 1907), Vol. II.

[18] C. G. Knott, *Life and Scientific Work of Peter Guthrie Tait* (Cambridge University Press, Cambridge, England, 1911).

[19] Ref. 15.

[20] P. G. Tait, "Clerk-Maxwell's Electricity and Magnetism," Nature 7, 478 (1873).

[21] P. G. Tait, "Clerk-Maxwell's Scientific Work," Nature 21, 317 (1880).

[22] H. W. Watson and S. H. Burbury, *Mathematical Theory of Electricity and Magnetism* (Oxford University Press, Oxford, England, 1885).

[23] O. Heaviside, *Electromagnetic Theory* (The Electrician Printing and Publishing Company, London, 1893), Vol. I.

[24] O. Heaviside, *Electrical Papers* (MacMillan and Company Ltd. London, 1892), Vol. I. (Reprinted from The Electrician, 3 January 1885.)

[25] O. Heaviside, Ref. 23, p. 67 (Reprinted from The Electrician, 29 May 1891.)

the equations of electromagnetism." Heaviside even uses this symmetry to make an extension of Maxwell's equations: he explicitly introduces a magnetic conduction-current term to match the electrical-conduction term, thus making the equations completely symmetrical except for signs, despite the recognition that "There is probably no such thing as a magnetic conduction current, with dissipation of energy."[26] This addition, although never gaining general acceptance, has been made by physicists in the present century for various reasons. Elsewhere,[27] we see that he considers this symmetry to be of assistance in calculations based on Maxwell's equations: "The method of treating Maxwell's electromagnetic scheme employed in the text (first introduced in "Electromagnetic Induction and its Propagation," *The Electrician*, 3 January 1885, and later) may, perhaps, be appropriately termed the Duplex method, since its characteristics are the exhibition of the electric, magnetic, and electromagnetic relations in a duplex form, symmetrical with respect to the electric and magentic sides. But it is not merely a method of exhibiting the relations which were formerly hidden from view by the intervention of the vector-potential and its parasites, but constitutes a method of working as well."

Webster[28] refers to Heaviside rather than Maxwell when he says: "These [curl **B**] equations are now completely analogous to the [curl **E**] equations (5) except for the difference of sign on the left. . . ." George Francis FitzGerald, another "follower" of Maxwell, in his very favorable review[29] of Heaviside's *Electrical Papers*, also mentions this aspect of Heaviside: "The duality of electricity and magnetism was an old and familiar fact. The inverse square law applied to both; every problem in one had its counterpart in the other. Oliver Heaviside has extended this to the whole of electromagnetics. By the assumption of the possibility of magnetic conduction he has made all the equations symmetrical. Every mathematician can appreciate the value and beauty of this." Hertz[30] does not refer directly to the symmetric aspects of Maxwell's equations, but he does write the equations in a contemporary manner (without vector notation), and then he remarks that "Mr. Oliver Heaviside has been working in the same direction ever since 1885. From Maxwell's equations he removes the same symbols as myself; and the simplest form which these equations thereby attain is essentially the same as that at which I arrive."

Perhaps it does not take us too far afield here to note Heaviside's pivotal influence in propagating Maxwell's ideas. He seems to have been the first person to investigate in many directions the consequences of the theory. We have already noted his interest in the basic formulation of the theory. He discovered the energy relation for an electromagnetic field independently of Poynting; he conducted extensive investigations on various types of electromagnetic waves; and he studied the radiation to be expected from a moving charge more adequately than had J. J. Thomson, thus originating the concept of electromagnetic mass which was to be developed by Lorentz and Abraham. Any careful perusal of the history of electromagnetic theory should devote considerable attention to Heaviside. One must agree with the citation accompanying his honorary degree from Göttingen in 1905: ". . . among the Propagators of the Maxwellian Science Easily the First."

Duhem[31] refers to the displacement current in his odd comparison of English and continental physicists. He complains that Maxwell suddenly introduces the concept with little careful preparation, as contrasted with what he would expect from a French or German physicist. He states: "This displacement current was introduced by Maxwell in order to complete the definition of the properties of a dielectric at a given instant. . . [it] has some close analogies with the conduction current. . . ."

Returning to our point of departure, we find

[26] O. Heaviside, Ref. 24, p. 441.

[27] O. Heaviside, "On the Forces, Stresses, and Fluxes of Energy in the Electromagnetic Field," Phil. Trans. Roy. Soc. London **183A**, 423–480 (1893).

[28] A. G. Webster, *The Theory of Electricity and Magnetism* (MacMillan and Company Ltd., London, 1897), p. 507.

[29] G. F. FitzGerald, "Heaviside's Electrical Papers," The Electrician, 11 August 1893, in: J. Larmor, *The Scientific Writings of the Late George Francis FitzGerald* (Hodges, Figgis, and Company, Dublin, Ireland, 1902), pp. 292–300.

[30] H. Hertz, *Electric Waves* (MacMillan and Company Ltd., London, 1900), p. 196. (Originally published in Göttingen Nachr., 19 March 1890.)

[31] P. Duhem, *The Aim and Structure of Physical Theory* (Princeton University Press, Princeton, New Jersey, 1954), Chap. IV.

that N. R. Campbell himself is not consistent in his view of the problem. In contrast to his passage in *What is Science*, he says in *Physics, the Elements*[32]: "The introduction [of the displacement current] . . . was suggested by Faraday's theory of the electrostatic field. . .". In another discussion of displacement current[33] esthetic considerations are not mentioned.

CONCLUSIONS

On the basis of the evidence just presented the following conclusions appear to be warranted:

(1) Maxwell consistently brings out two related factors whenever he uses the displacement current. First, the curl **H** equations without such a term would imply that conduction currents must flow only in closed loops, an unacceptable situation if one means conduction current. We note this conclusion in I, before there is any hint of the additional current. But the "true current" *does* flow only in closed loops. Also the equation of continuity for current is grouped with the field equations in the next two papers. Second, the displacement current is a physical current in the dielectric medium, just as "real" as a conduction current. The "Equations of True Currents" emphasize this. He even discusses the difficulties in attempting to measure the current. It must be remembered that the vacuum in terms of electromagnetic theory is a concept foreign to Maxwell, so dielectric includes the case we would describe as empty space. As Heaviside says, "ether is dielectric." The argument of changing displacements of charge (measured by the electric displacement) in the molecules of the medium as a current occurs over and over in only slightly different forms.

(2) There is no direct evidence to support the notion that Maxwell introduced the displacement-current term in order to improve the symmetry of the electromagnetic field equations. No statement occurs in the three papers or in the *Treatise* which can be so interpreted; in fact, only the alternative reasons for the introduction [stated in (1) above] are found. The closest approach appears in the discussion of symmetry in the "Address" nine years after he first introduces displacement current but, as noted, one must read beyond what is actually stated to see the discussion referring to displacement current. The fact that the two sets of three symmetrical equations are stated in III as three sets of equations (thus lacking the symmetrical properties) argues against Campbell; but II is more favorable to him in this regard.

Campbell's alternative explanation of the change must also be weighted against him. Furthermore, one notes in *What is Science* that he assigns the date "about 1870." This is some ten years later than Maxwell began to use displacement current, but the date corresponds curiously to the "Address." The origin of Campbell's statement suggested by this consideration would have to be regarded as speculative. A more likely possibility is that Campbell's argument is an embellishment on Heaviside's duplex form, although Heaviside does not use it to justify the existence of the displacement current. As we have seen, Heaviside himself considers the parallel between electricity and magnetism to be his own, and Webster and FitzGerald agree with him.

This negative conclusion is subject to all the usual qualifications demanded by a null result. First, a more thorough study with sources as yet unknown here might reveal a basis for the symmetry argument. Maxwell's letters and papers in the Cavendish Laboratory might contribute additional insights. Second, even if no support is found in an ideal case in which all *possible* sources are known and examined, the suggestion would still not be impossible. There is always a gap (even in a Kepler) between the creative man and the writing man, between the thought processes behind a discovery and the later description of that discovery in books and papers; it is this which makes the study of "scientific method," what the scientist actually does, so difficult.

ACKNOWLEDGMENTS

The author is grateful to Professor Arnold Arons, Professor I. Bernard Cohen, Professor Gerald Holton, and Professor Melba Phillips for advice, encouragement, and assistance.

[32] N. R. Campbell, *Physics, The Elements* (Cambridge University Press, Cambridge, England, 1919), reprinted as *Foundations of Science* (Dover Publications, New York, 1957).

[33] N. R. Campbell, *Modern Electrical Theory* (Cambridge University Press, Cambridge, England, 1913).

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Calculation of Magnetic and Electric Fields from Displacement Currents

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We calculate the magnetic induction from the integral form of the Biot–Savart law, $\mathbf{B}=\mu_0/4\pi\int(\mathbf{J}+\dot{\mathbf{D}})\times \mathbf{r}dV/r^3$. In the quasistatic case, using only the scalar electric potential, we transform the volume integral of $\dot{\mathbf{D}}$ into an inner and an outer surface integral, both of which vanish except for a contribution from the polarization current in dielectric materials. Hence the induction is calculable from the sum of the conduction- and polarization-current densities alone. This result has no bearing on the calculation of the induction from Ampere's law, where we must use the entire displacement-current density. In the converse problem of an induced electric field there is no magnetic conduction current, and the quasistatic magnetic displacement current arises from a changing electric current in a closed circuit. We express **H** through the scalar magnetic potential, which is discontinuous on a surface bounded by the electric circuit. We obtain the induced electric field from a volume integral like the Biot–Savart integral above, and as before we transform it into surface integrals. There are two nonvanishing contributions. One is over both sides of the surface which is bounded by the electric circuit; it gives an expression for the electric field which we commonly compute from the vector potential. The second contribution reappears as a volume integral of magnetization currents in magnetic material.

GENERAL DISCUSSION

MANY of us have been taught that "the electric displacement current has the same effect in producing a magnetic field as does the conduction current." We have taught this to our students, and we have proved that the statement is true, in the quasistatic case. However, our proofs have calculated the effect of the displacement current from Ampere's law,

$$\oint \mathbf{B}\cdot d\mathbf{s}=\mu_0\int \dot{\mathbf{D}}\cdot d\mathbf{S}, \qquad (1)$$

for a surface through which the conduction current is zero.[1] We have then compared the result with that which is given by the Biot–Savart law using only the conduction-current density

$$\mathbf{B}=\frac{\mu_0}{4\pi}\int\frac{\mathbf{J}\times\boldsymbol{\rho}}{\rho^3}dV. \qquad (2)$$

The results agree, and they are both correct, but a student should quite properly ask why we do not use the total current density, $\mathbf{J}+\dot{\mathbf{D}}$, in Eq. (2) instead of only **J**. The answer is that we should use the total current density to find the induction due to the current in a finite region, but (if there are no material dielectrics present) the integral over all space of $\dot{\mathbf{D}}$ vanishes. French and Tessman have pointed this out in a paper published in this Journal.[2]

In their demonstration French and Tessman quote a development by Planck that uses a vector potential which is rather unusual in that it is based on the displacement current, not the conduction current, and it uses a scalar electric potential as well.[3] In this paper we achieve the same result using only the scalar potential. We also take into account material dielectrics and imperfect conductors.

The converse problem concerns the electric field induced by a magnetic displacement current. Papers by Ramanathan and by Sears have reminded us of some reciprocal relations between the electric and magnetic quantities; there is an exact analog to the Biot–Savart integral, which gives the induced electric field.[4,5] We consider the case when the magnetic displacement current is quasistatic, and arises from an electric current. The integral then has a nonvanishing contribution which comes from the discontinuity of the scalar magnetic potential on the arbitrarily fixed surface bounded by the electric circuit. The resulting expression for the electric field is one

[1] R. M. Whitmer, *Electromagnetics* (Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1962), 2nd ed., Sec. 11.2.

[2] A. P. French and J. R. Tessman, Am. J. Phys. **31**, 201 (1963).

[3] Max Planck, *Theory of Electricity and Magnetism* (The Macmillan Company, New York, 1949), p. 195 ff.

[4] K. G. Ramanathan, Contemp. Phys. **3**, 286 (1962).

[5] F. W. Sears, Am. J. Phys. **31**, 439 (1963).

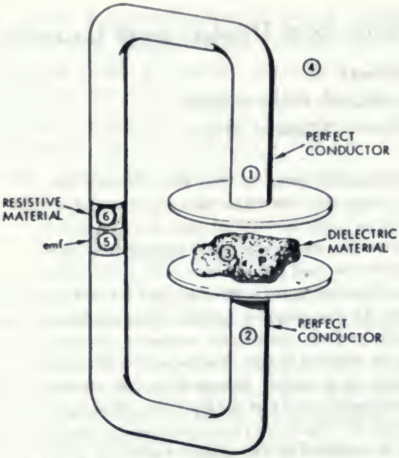

FIG. 1. An electric circuit which contains a source of emf, perfectly—and imperfectly—conductive regions and material dielectric.

which we often compute from the conventional vector potential. Many students may feel more comfortable with the vector potential if they are shown that its predictions agree with those obtained in other ways. The integral also gives a magnetization-current term from magnetic material in the field.

The expositions in Refs. 1 and 2, and that of the present paper as well, deal only with the quasistatic case; that is, one in which the solution is given with sufficient accuracy if we

(1) calculate static electric and dc magnetic fields,

(2) multiply the fields by a time-dependence factor, and finally

(3) correct the fields for the contributions that arise from the electric and magnetic displacement currents which follow as a consequence of (2).

The principal characteristic of the quasistatic case is that radiation is ignored. We may also describe it as a situation in which the charges, currents and the point of observation are confined to a region in space whose dimensions are small compared with the wavelength of the highest-frequency spectral component of the currents and motions of the charges. Still another way of looking at these things is to observe that, in the quasistatic electric case, $\operatorname{div}\dot{\mathbf{D}} = \dot{Q}_V$ and $\operatorname{curl}\dot{\mathbf{D}} = 0$ (where $\dot{Q}_V$ is the time rate of change of the volume density of electric charge). It follows that $\dot{\mathbf{D}}$ can be derived from a scalar potential which is continuous. On the other hand $\operatorname{div}\dot{\mathbf{B}}$ is zero always, whence even in the quasistatic magnetic case (more accurately, "quasi-dc"), if we derive $\dot{\mathbf{B}}$ from a scalar potential, that potential must have the discontinuity on the surface bounded by the circuit which we have mentioned earlier.

In our calculations we use two vector integral transformations which may be unfamiliar. They are

$$\int \operatorname{curl}\mathbf{\Gamma}\, dV = -\int \mathbf{\Gamma} \times d\mathbf{S} \qquad (3)$$

and

$$\int_{\substack{\text{open}\\ \text{surface}}} \operatorname{grad}\psi \times d\mathbf{S} = -\int \psi d\mathbf{s}, \qquad (4)$$

where $\mathbf{\Gamma}$ is any vector field, and ψ a scalar function. To prove the first of these statements we apply the divergence theorem to the vector product of a constant vector with $\mathbf{\Gamma}$. The other we derive by applying Stokes' theorem to the product of ψ with a constant vector.

THE MAGNETIC FIELD DUE TO ELECTRIC CURRENTS

According to the Biot–Savart law, the contribution which we might expect would be made to the magnetic induction $\mathbf{B}$, by the electric displacement-current density $\dot{\mathbf{D}}$ is

$$\mathbf{B}(\mathbf{r},\dot{\mathbf{D}}) = \frac{\mu_0}{4\pi}\int_{\substack{\text{all}\\ \text{space}}} \frac{\dot{\mathbf{D}}(\mathbf{r}') \times \boldsymbol{\rho}}{\rho^3} dV(\mathbf{r}'), \qquad (5)$$

where

$$\boldsymbol{\rho} = \mathbf{r} - \mathbf{r}'.$$

If we express the displacement-current density in terms of the scalar electric potential ϕ, Eq. (5) becomes

$$\mathbf{B}(\mathbf{r},\dot{\mathbf{D}}) = -\frac{\mu_0}{4\pi}\int_{\substack{\text{all}\\ \text{space}}} \frac{\epsilon(\mathbf{r}')\operatorname{grad}\dot{\phi}(\mathbf{r}') \times \boldsymbol{\rho}}{\rho^3} dV(\mathbf{r}'). \qquad (6)$$

Now

$$\operatorname{curl}\left(\phi\frac{\boldsymbol{\rho}}{\rho^3}\right) = \operatorname{grad}\phi \times \frac{\boldsymbol{\rho}}{\rho^3} + \phi \operatorname{curl}\frac{\boldsymbol{\rho}}{\rho^3},$$

and

$$\operatorname{curl}\frac{\boldsymbol{\rho}}{\rho^3} = \operatorname{curl}\operatorname{curl}\frac{1}{\rho} \equiv 0,$$

so that

$$\mathbf{B} = -\frac{\mu_0}{4\pi}\int_{\substack{\text{all}\\ \text{space}}} \epsilon \,\text{curl}\left(\phi\frac{\boldsymbol{\varrho}}{\rho^3}\right) dV. \qquad (7)$$

We want to transform Eq. (7) into an integral over a surface which encloses an entire system such as that shown in Fig. 1, where we have a source of emf, perfectly and imperfectly conducting regions and material dielectric. We must first apply the transformation to each region separately, because of the discontinuities of the dielectric constant and of the derivatives of the potential at the various interfaces. Then the integral of Eq. (7) becomes

$$\int_{\substack{\text{all}\\ \text{space}}} \epsilon \,\text{curl}\left(\phi\frac{\boldsymbol{\varrho}}{\rho^3}\right) dV = \sum_{1-6}\int \phi\frac{\boldsymbol{\varrho}}{\rho^3}\times d\mathbf{S}. \qquad (8)$$

The surface integrals contain ϕ as a factor, with no space derivatives. On the surfaces of the perfect conductors the integrals vanish because ϕ has no spatial dependence and $\int (\boldsymbol{\varrho}/\rho^3)\times d\mathbf{S} = 0$. Over the source of emf, ϕ is zero. On the interface between dielectric and free space the integrals from Regions 3 and 4 give us

$$(\epsilon-\epsilon_0)\int_{\substack{3-4\\ \text{interface}}} \phi\frac{\boldsymbol{\varrho}}{\rho^3}\times d\mathbf{S} = -(\epsilon-\epsilon_0)\int_3 \text{curl}\left(\phi\frac{\boldsymbol{\varrho}}{\rho^3}\right) dV, \qquad (9)$$

where the $d\mathbf{S}$ on the left side is directed outward from Region 3. With a little manipulation we can write the volume integral of Eq. (9) in terms of the electric field, so that it becomes

$$(\epsilon-\epsilon_0)\int_{\substack{3-4\\ \text{interface}}} \phi\frac{\boldsymbol{\varrho}}{\rho^3}\times d\mathbf{S} = -(\epsilon-\epsilon_0)\int_3 \dot{\mathbf{E}}\times\frac{\boldsymbol{\varrho}}{\rho^3}dV.$$

But $(\epsilon-\epsilon_0)\mathbf{E}$ is the polarization $\mathbf{P}$, of the dielectric material, so that Eq. (9) becomes

$$(\epsilon-\epsilon_0)\int_{\substack{3-4\\ \text{interface}}} \phi\frac{\boldsymbol{\varrho}}{\rho^3}\times d\mathbf{S} = \int_3 \frac{\dot{\mathbf{P}}\times\boldsymbol{\varrho}}{\rho^3}dV. \qquad (10)$$

The quantity $\dot{\mathbf{P}}$ is the polarization-current density. If there is any polarization of the resistive region there will be a contribution like Eq. (10) from Region 6 also; otherwise the contribution from Region 6 vanish.

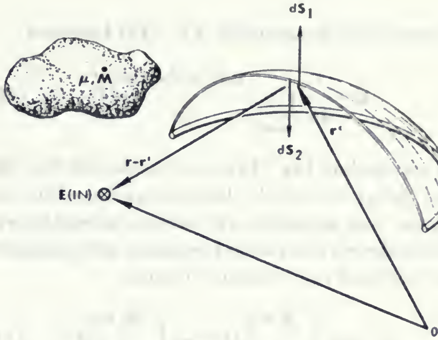

FIG. 2. A region which contains some magnetic material and a circuit carrying a time-varying electric current.

The only term on the right side of Eq. (8) for which we have not yet accounted is the integral over the outer surface of Region 4. Let us write it as

$$\text{limit as boundary} \to \infty \int_4 \phi(\mathbf{r}')\frac{\boldsymbol{\varrho}}{\rho^3}\times d\mathbf{S}(\mathbf{r}'). \qquad (11)$$

For a finite charge and current distribution ϕ approaches zero at least as fast as $1/r'^2$, while the product $\boldsymbol{\varrho}\times d\mathbf{S}/\rho^3$ becomes independent of r', when r' is sufficiently large; hence the integral vanishes. Finally, then, the entire magnetic field can be expressed as an integral over the conduction- and polarization-current densities alone:

$$\mathbf{B}(\mathbf{r}, \mathbf{J}+\dot{\mathbf{D}}) = \frac{\mu_0}{4\pi}\int_{\substack{\text{all}\\ \text{space}}} \frac{(\mathbf{J}+\dot{\mathbf{P}})\times\boldsymbol{\varrho}}{\rho^3}dV. \qquad (12)$$

THE ELECTRIC FIELD INDUCED BY MAGNETIC DISPLACEMENT CURRENTS

In our notation, the integral of Sears' Eq. (1b) is

$$\mathbf{E}(\mathbf{r},\dot{\mathbf{B}}) = -\frac{1}{4\pi}\int_{\substack{\text{all}\\ \text{space}}} \frac{\dot{\mathbf{B}}(\mathbf{r}')\times\boldsymbol{\varrho}}{\rho^3}dV(\mathbf{r}'). \qquad (13)$$

which is the exact analog of our Eq. (5). We consider $\dot{\mathbf{B}}$, the magnetic displacement current, to be due to a changing electric current in a circuit. As the archetype of a circuit we take a simple current loop, as in Fig. 2. The current produces a scalar magnetic potential ϕ_m, whose negative gradient is the magnetic field $\mathbf{H}$

$$\mathbf{H} = -\text{grad}\phi_m.$$

In terms of this potential, Eq. (13) becomes

$$\mathbf{E}=\frac{1}{4\pi}\int_{\substack{\text{all}\\ \text{space}}}\frac{\mu\,\text{grad}\dot{\phi}_m\times\boldsymbol{\varrho}}{\rho^3}dV. \tag{14}$$

We manipulate Eq. (14) much as we did Eq. (6). Here things are simpler because we have but two regions. Just as before, the surface integrals over the interference between free space and magnetic material lead to a volume integral,

$$(\mu-\mu_0)\int\frac{\dot{\mathbf{H}}\times\boldsymbol{\varrho}}{\rho^3}dV=\mu_0\int\frac{\dot{\mathbf{M}}\times\boldsymbol{\varrho}}{\rho^3}dV. \tag{15}$$

The quantity **M** is the magnetization of the magnetic material, and $\dot{\mathbf{M}}$ is the magnetization-current density.

The integral over the outer surface vanishes for the same reason as did the corresponding integral over electric currents. In addition to the integral of the magnetization, we have left

$$\frac{\mu_0}{4\pi}\int_{S_1+S_2}\frac{\dot{\phi}_m\boldsymbol{\varrho}}{\rho^3}\times d\mathbf{S},$$

where S_1 and S_2 are the two sides of the surface, bounded by the electric current, on which the potential is discontinuous. For opposing surface elements $d\mathbf{S}_1$ and $d\mathbf{S}_2$, it is apparent that

$$\begin{aligned}\dot{\phi}_m(1)d\mathbf{S}_1+\dot{\phi}_m(2)d\mathbf{S}_2&\\ &=\dot{\phi}_m(1)d\mathbf{S}_1+(\dot{\phi}_m(1)+\Delta\dot{\phi}_m)(-d\mathbf{S}_1)\\ &=-\Delta\dot{\phi}_m d\mathbf{S}_1\\ &=-\dot{I}d\mathbf{S}_1.\end{aligned} \tag{16}$$

Here the positive direction of circulation of $\dot{I}$ (but not necessarily that of I) is defined with respect to $d\mathbf{S}_1$ by the usual right-hand rule.[6]

When we collect the results we find that

$$\mathbf{E}(\mathbf{r},\dot{\mathbf{B}})=-\frac{\mu_0}{4\pi}\dot{I}\int_{S_1}\frac{d\mathbf{s}(\mathbf{r}')}{\rho^3}-\frac{\mu_0}{4\pi}\int\frac{\dot{\mathbf{M}}\times\boldsymbol{\varrho}}{\rho^3}dV. \tag{17}$$

The first term on the right side of Eq. (17) is familiar; it is the expression which we usually derive by using the vector potential. If we compare the second term with the results of the preceding section we see that the magnetization current contributes to the induced electric field in the same way as the electric polarization current does to the magnetic field—that is, in this respect the magnetization current resembles a conduction current. Phenomenologically, it is immaterial whether a body becomes magnetized because Amperian currents circulate in it or because magnetic charges move apart, like the electric charges in a polarized medium.

ACKNOWLEDGMENTS

The ideas expressed in this paper have been greatly clarified by discussions with R. S. Margulies, R. F. Soohoo and V. Rojansky.

[6] See, for example, Ref. 1, pp 185–6. Here, the discontinuity in ϕ_m is incorrectly given as $\mu_0 I_{dc}$; the factor of μ should be deleted.

Does the displacement current in empty space produce a magnetic field?

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It is now over a hundred years (1861) since Maxwell[1] introduced the displacement current ($\epsilon_0\dot{E} + \dot{P}$), and over 70 years since Einstein[2] introduced the theory of special relativity, which made the theories of the luminiferous ether "superfluous." There is still confusion in many introductory textbooks on classical electromagnetism about the role of the displacement current in empty space.

When the displacement current in empty space is first introduced, many authors interpret the equation

$$\text{curl}\mathbf{B} = \mu_0\epsilon_0\dot{\mathbf{E}} \qquad (1)$$

by making statements such as: "A changing electric field produces a magnetic field."

In the 19th century, the ether was treated as a special type of dielectric, and it was believed that the roles of the $\epsilon_0\dot{E}$ and the $\dot{P}$ terms were similar. Nowadays the $\epsilon_0\dot{E}$ term is not associated with the displacements of elements of the ether. The quasistatic case was considered by French and Tessman[3] and by Purcell,[4] who pointed out that, in the quasistatic limit, it does not matter whether or not the displacement current in empty space ($\epsilon_0\dot{E}$) is included when the Biot–Savart law is applied, provided the integration is over the whole of space. Whitmer[5] showed that, in the presence of dielectrics, the $\dot{P}$ term in the Biot–Savart law did contribute to the magnetic field. This is to be expected in contemporary theories since the $\dot{P}$ term is associated with the movements of charges on the atomic scale inside dielectrics.

The Biot–Savart law is not applicable at high frequencies when retardation and radiation effects are important. At high frequencies it is convenient to use the vector potential. The displacement current in empty space ($\epsilon_0\dot{E}$) should *not* be included in the expression for the retarded vector potential (Lorentz gauge).

A discussion of the original arguments that led Maxwell to introduce the concept of the displacement current was given by Bork[6] and will not be repeated here. There is no doubt that at the time Maxwell[7] wrote his *Treatise* (1873), he assumed that the $\epsilon_0\dot{\mathbf{E}}$ term did give rise to a magnetic field, and he included $\epsilon_0\dot{\mathbf{E}}$ as well as $\dot{\mathbf{P}}$ in the expression he developed for the vector potential using the Coulomb gauge.

Since our discussion is confined to the role of the $\epsilon_0\dot{\mathbf{E}}$ term, it will be assumed that $\mu_r = 1$ and $\epsilon_r = 1$. Substituting the equation

$$\mathbf{E} = -\text{grad}\phi^* - \frac{\partial \mathbf{A}^*}{\partial t} \quad (2)$$

into the equation

$$\text{div}\mathbf{E} = \rho/\epsilon_0,$$

we have

$$\text{div grad}\phi^* + \text{div}\dot{\mathbf{A}}^* = -\rho/\epsilon_0.$$

Using the Coulomb gauge, in which

$$\text{div}\mathbf{A}^* = 0, \quad (3)$$

we have

$$\nabla^2\phi^* = -\rho/\epsilon_0. \quad (4)$$

Asterisks are used to indicate that the potentials are in the Coulomb gauge.

By analogy with Poisson's equation, the solution of Eq. (4) is

$$\phi^*(x,y,z,t) = \frac{1}{4\pi\epsilon_0}\int \frac{\rho(x',y',z',t)}{r}\,dx'\,dy'\,dz', \quad (5)$$

where $\rho(x',y',z',t)$ is the charge density at a point having coordinates x',y',z' at a distance r from the field point at x,y,z at the time t. The potential ϕ^* is sometimes called the ***instantaneous scalar potential***.

Substituting $\mathbf{B} = \text{curl}\mathbf{A}^*$ into the Maxwell equation

$$\text{curl}\mathbf{B} = \mu_0(\mathbf{J} + \epsilon_0\dot{\mathbf{E}}), \quad (6)$$

where $\mathbf{J}$ is the conduction current density of free charges, we have

$$\text{curl curl}\mathbf{A}^* = \text{grad div}\mathbf{A}^* - \nabla^2\mathbf{A}^*$$
$$= \mu_0(\mathbf{J} + \epsilon_0\dot{\mathbf{E}}) = \mu_0\mathbf{C},$$

where

$$\mathbf{C} = \mathbf{J} + \epsilon_0\dot{\mathbf{E}} \quad (7)$$

is what Maxwell called the "true current on which the electromagnetic phenomena depend." Using the Coulomb gauge, Eq. (3), we have

$$\nabla^2\mathbf{A}^* = -\mu_0\mathbf{C} = -\mu_0(\mathbf{J} + \epsilon_0\dot{\mathbf{E}}). \quad (8)$$

Maxwell[7] wrote the solution of Eq. (8) (which is similar to Poisson's equation, *if* C is given at all points of space) in the form

$$\mathbf{A}^*(x,y,z,t) = \frac{\mu_0}{4\pi}\int \frac{\mathbf{J}(x',y',z',t) + \epsilon_0\dot{\mathbf{E}}(x',y',z',t)}{r}\,dx'\,dy'\,dz'. \quad (9)$$

The integration in Eq. (9) is carried out over the whole of space at a *fixed* time t.

Following Maxwell, Eq. (9) was interpreted in the 19t century by saying that both the conduction current and th displacement current contributed to the magnetic field an that the interaction propagated at *infinite* speed from th source to the field point. The vector potential $\mathbf{A}^*$ is some times called the *instantaneous vector potential*. Ideas base on Eq. (9) fitted in with the idea of instantaneous action a a distance and were felt to be consistent with Newtonia mechanics. The position at the end of the 19th century i illustrated by the following quotation from Poincar (1894)[8]:

> In calculating A Maxwell takes into account th currents of conduction and those of displacement and he supposes that the attraction takes place ac cording to Newton's law, i.e. instantaneously. But i calculating [the retarded potential] on the contrar we take account only of conduction currents and w suppose that the attraction is propagated with th velocity of light. . . . It is a matter of indifferenc whether we make this hypothesis [of a propagatio in time] and consider only the induction due to con duction currents, or whether like Maxwell, we retai the old law of [instantaneous] induction and consid er both conduction and the displacement currents.

This analysis shows how the use of different gauges i the 19th century leads to the introduction of very differen models for the field equations of classical electromagne- tism.

In order to calculate $\mathbf{A}^*$ from Eq. (9), we would need t be given *both* $\mathbf{J}$ and $\epsilon_0\dot{\mathbf{E}}$ at all points of space. In cases o practical interest, the displacement current density $\epsilon_0\dot{\mathbf{E}}$ i *not* given, but has to be calculated from the charge an current distributions. In order to calculate E, we woul normally use Eq. (2), but Eq. (2) includes the vector po tential, which is what Eq. (9) is supposed to give. Hence, Eq (9) is never used in practice.

A few attempts were made to apply Eq. (9) in the 19t century. For example, J. J. Thomson[9] tried, without muc success, to calculate the magnetic field of a moving charg using Eq. (9). When the Coulomb gauge is used nowaday (e.g., by Jackson[10] and by Heitler[11]), the displacemen current $\epsilon_0\dot{\mathbf{E}}$ is eliminated from Eq. (8) by using Eq. (2) Then

$$\nabla^2\mathbf{A}^* - \frac{1}{c^2}\frac{\partial^2\mathbf{A}^*}{\partial t^2} = -\mu_0\mathbf{J} + \mu_0\epsilon_0\,\text{grad}\dot{\phi}^* = -\mu_0\mathbf{J}_t, \quad (10)$$

where

$$\mathbf{J}_t = \mathbf{J} - \epsilon_0\,\text{grad}\dot{\phi}^* \quad (11)$$

is called the transverse current density, which can be cal- culated from $\mathbf{J}$, the conduction current density of free charge, and the value of ϕ^* given by Eq. (5). The dis- placement current in empty space ($\epsilon_0\dot{\mathbf{E}}$) does *not* appear in Eq. (10).

Since the displacement current in empty space does not appear in the differential equations for the potentials ϕ and $\mathbf{A}$ in either the Coulomb or the Lorentz gauge, it seems pointless to make statements such as "a changing electric field produces a magnetic field," since this is merely fol- lowing a historical tradition based on obsolete models of the ether and on an obsolete, unsatisfactory way of using the

Coulomb gauge. There is no need to say that $\dot{E}$ "produces" curlB or vice versa, to interpret Eq. (1). It is better to interpret Eq. (1) as a relation between the resultant field vectors E and B valid at *any* field point in empty space: given curlB we can calculate $\dot{E}$, or given $\dot{E}$ we can calculate curlB.

It was shown by Rosser[12] that, if there is a moving charge distribution at the field point, then the $\mu_0 J$ term must be added to Eq. (1), giving Eq. (6), so as to compensate for the fact that, when an element of charge passes a field point, the electric field due to that element of charge reverses direction, whereas its contribution to curlB does not reverse direction.

When the Coulomb gauge is applied in the way described by Jackson,[10] it gives the same results for E and B as the Lorentz gauge. It was shown by Brill and Goodman[13] that the apparent instantaneous Coulomb interaction given by Eq. (5) is compensated by the contribution to A* of the transverse current density, given by Eq. (11), such that the total electric field given by Eq. (2) is retarded and equal to the value calculated using the Lorentz gauge. The choice of gauge is a matter of convenience. The Lorentz gauge is simpler to use in classical electromagnetism, whereas the Coulomb gauge has some advantages in the quantum theory of radiation.[11]

A lot of the confusion about the role of the displacement current in empty space ($\epsilon_0 \dot{E}$) might be avoided, if it were called something else that did not include the word current.[14] If a name is needed, it could be called the Maxwell term in honor of the man who first introduced it.

[1]J. C. Maxwell, *The Scientific Papers of James Clerk Maxwell* (Dover, New York, 1965), Vol. I, pp. 451–525.
[2]A. Einstein, Ann. Phys. (Leipzig) 17, 891 (1905).
[3]A. P. French and J. R. Tessman, Am. J. Phys. 31, 201 (1963).
[4]E. M. Purcell, *Electricity and Magnetism* (McGraw-Hill, New York 1965), p. 261.
[5]R. M. Whitmer, Am. J. Phys. 33, 481 (1965).
[6]A. M. Bork, Am. J. Phys. 31, 854 (1963).
[7]J. C. Maxwell, *A Treatise on Electricity and Magnetism* (Dover, New York, 1954), Vol. 2, p. 255.
[8]A. O'Rahilly, *Electromagnetics* (Longman's Green, London, 1938), p. 176.
[9]J. J. Thomson, Philos. Mag. 11, 229 (1881).
[10]J. D. Jackson, *Classical Electrodynamics*, 2nd ed. (Wiley, New York, 1975), p. 221.
[11]W. Heitler, *Quantum Theory of Radiation*, 3rd ed. (Oxford U. P., London, 1954).
[12]W. G. V. Rosser, Am. J. Phys. 43, 502 (1975).
[13]O. W. Brill and B. Goodman, Am. J. Phys. 35, 832 (1967).

[14]Another idea still prevalent in introductory text books on classical electromagnetism is that the equation

$$\mathrm{div}(J + \epsilon_0 \dot{E}) = 0, \tag{R.1}$$

which can be obtained by taking the divergence of Eq. (6), implies that the "total current" is continuous. There is no need to interpret the $\epsilon_0 \dot{E}$ term in Eq. (R.1) as an electric current. Integrating Eq. (R.1) over a finite volume and applying Gauss's theorem of vector analysis, we have

$$\int J \cdot dS = -\epsilon_0 \frac{\partial}{\partial t} \int E \cdot dS. \tag{R.2}$$

The left-hand side of Eq. (R.2) is the charge crossing the surface of the volume per second. If charges, each of magnitude $+Q$, are leaving the surface at the rate of N per second, the left-hand side is equal to NQ. According to Gauss's theorem, each charge $+Q$ leaving the surface reduces the flux of E from the surface by Q/ϵ_0. Hence, the right-hand side of Eq. (R.2) is also equal to NQ. Thus, Eqs. (R.1) and (R.2) relate the rate at which charge is crossing a closed surface to the consequential decrease in electric flux from that surface, associated with the decrease in the total charge inside the surface.

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Measuring the unmeasurable

After more than a century, the reality of Maxwell's displacement current has been demonstrated direct measurement. So, too, but less conclusively, has been the Aharonov/Bohm effect.

One of the big surprises of Maxwell's theory of electromagnetism was his introduction of the concept of displacement current. By Maxwell's time, it was generally understood that an electrical current in a conductor would generate a magnetic field (Ampère's law applies). In modern language, the relationship is that the curl of **H**, the magnetic field strength, is equal to the current, or that $\nabla \times \mathbf{H} = \mathbf{J}$, where **H** is the field and **J** the current, both of them vector quantities. Maxwell's innovation was to add to the right-hand side of the equation the rate of change with time of the electrical displacement, **D**, related to the electric field strength by $\mathbf{D} = \epsilon\mathbf{E}$, where ϵ is the scalar permittivity of the material, itself related to the dielectric constant by a numerical factor depending only on the choice of units. Now the displacement current has been measured for what appears to be the first time.

None of this implies that the reality of the displacement current has been in limbo in the interval. Indeed, were it not for the displacement current, it would not be possible to deduce from Maxwell's equations that electromagnetic waves have the properties of light. Maxwell was well aware of the difficulty he was creating. Indeed, D.F. Bartlett and T.R. Corle from the University of Colorado at Boulder, who have now measured a displacement current directly (*Phys. Rev. Lett.* **55**, 59; 1985), quote him as describing as one of the "chief peculiarities" of his thesis "that the time derivative of the electric displacement must be taken into account".

The principle of the measurement is a good deal simpler than the practice. The obvious first step is to create a reasonable source of displacement current. What could be simpler than the steady increase of electrical displacement between the plates of a capacitor during the process of being charged, most simply by connecting its plates to a physical electric current?

Bartlett and Corle point out two obvious snags. First, the voltage would quickly reach the point at which there would be a spark between the capacitor plates. Second, since the obvious way of measuring the displacement current is to measure the associated magnetic field, the feasibility of the measurement is determined by the relative magnitude of the field and the sensitivity of available measuring devices. Bartlett and Corle point out that for realistic capacitors, the expected magnitude of the magnetic field will be measured in micro-gauss.

From there, the design of the measurement is determined. The ideal of a direct-current measurement is unattainable, but a low-frequency current will do instead provided that the response-time of the ultimate measuring device is faster than the oscillation. The other requirement, that it should be possible to measure magnetic fields in the micro-gauss region, points uniquely to a SQUID (for superconducting quantum interference detector). And that, inevitably, points to the source of the complexity of the measurement, the need to contain the equipment in liquid helium.

Bartlett and Corle use a capacitor consisting of a pair of circular plates 7.6 cm in diameter and separated by 1.22 cm. The magnetic field between them is measured by a coil 1.5 mm in diameter encased in a stainless steel tube which, at liquid helium temperatures, acts as a shield against stray electric fields. The SQUID itself, based on a Josephson junction, is enclosed in a superconducting lead shield. If the arrangement were strictly symmetrical, the magnetic field induced by the displacement current, at some given phase of the driving current, would be represented by concentric circular lines of force with the field strength increasing linearly from the centre to the edge of the plates and then decreasing inversely with distance from the axis of symmetry.

At least to a first approximation, the geometry is exactly like that of the magnetic field associated with a current in a linear conductor except that, now, the current is displacement current and distributed across the whole area of the plates.

The complications are horrendous. Magnetic fields from the cables carrying the current are an obvious nuisance, if only because the measurement must be made inside a liquid-helium Dewar vessel and also inside a shield against stray magnetic fields from elsewhere. (The shield is a spherical copper vessel coated on the inside by superconducting lead/tin solder and filled with helium.) The leads carrying current to the plates are bent so that their final separate approach to the capacitor is along the axis of the arrangement, and also that the magnetic field generated by the power supply can be measured simply by rotating the measuring coil through 90 degrees. The use of an alternating power supply has the advantage of allowing the phase of the osci tion of the displacement current to be termined directly.

The only surprise is the precision of result. A plot of the field strength agai distance from the centre of the plate: indeed a straight line, whose slope is termined by the small scatter of points within three parts in 100. The measu slope differs from that calculated from dimensions of the capacitor and the ot parameters of the measurement by l than five per cent, possibly explained the intervention of a steel tube betwe the two plates.

Not all physical measurements of t kind are so unsurprising, demonstrati as it were of the ingenuity of which ph cists are capable. A few weeks ago (*Ph Rev. Lett.* **54**, 2469; 1985), Giorgio M teucci and Guilo Pozzi from the Unive ty of Bologna reported a measurem designed to verify the reality of t Aharonov/Bohm effect, the quant phenomenon by means of which the ph of the wave function describing a parti (such as an electron) should be affected the electromagnetic potential of an el tromagnetic field even when the partic are not subjected to physical forces.

One of the first demonstrations of t effect, in which Matteucci and Pozzi a had a hand, consists in arranging tha beam of electrons will travel on either si of a superconducting tube with a magne field along its axis in such a way t magnetic forces do not affect the el trons. Although the apparent physi tracks of the electrons are unchange their phases are altered by the presence the confined magnetic field, and interf ence fringes produced as a result.

What Matteucci and Pozzi have n done is to repeat the experiment with thin platinum wire coated on one side or with a thin layer of aluminium. Because the contact potential between the t metals, the electrons see the wire as if were an unsymmetrical distribution electric charge, but because the wire thin, there is no effective force on t electrons passing on one side or the othe But yet again, because in this case t electrostatic potential is different on o side of the wire from the other, the phas change and electron interference fring are produced. Indeed, the pattern of t fringes can be changed as the wire is r tated about its axis which will seem y another *tour de force*.

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Action et réaction en electrodynamique

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Abstract. The principle of action and reaction (PAR) is often presented in a way that neglects the possible role played by the intermediate field of the interaction. Now this field is endowed with momentum as well as energy and angular momentum etc. Therefore, it can play the same part as that of a 'material body'. We describe here a simple model that demonstrates this property for electromagnetic interactions.

Resumé. Le principe de l'action et de la réaction (PAR) est souvent présenté dans la littérature en négligeant le rôle éventuel du champ intermédiaire de l'interaction. Or ce champ contient de l'impulsion, de l'énergie, du moment angulaire etc. Il peut donc jouer un rôle analogue à celui d'un 'corps matériel'. On décrit ici un modèle simplifié qui exhibe cette propriété pour l'interaction électromagnétique.

1. Introduction

On présente souvent le principe de l'action et réaction (PAR) en disant que les forces d'interaction $\boldsymbol{F}_{12}$ et $\boldsymbol{F}_{21}$ entre deux corps sont telles que $\boldsymbol{F}_{12}=-\boldsymbol{F}_{21}$ et que leurs supports (ou droite d'action) sont confondus quelles que soient les interactions entre ces corps (Viennot 1982, Ménigaux 1986).

Si on peut l'admettre pour les interactions de contact réduites à un point, il n'en va pas de même en général pour les interactions 'à distance' car dans ce cas il y a un champ, servant d'intermédiaire à l'interaction, qui possède une impulsion (un moment angulaire, une énergie etc.), comme tout corps 'matériel', et qui peut être mise en évidence indépendamment de toute propagation. Les forces s'exerçant sur chaque corps n'ont alors aucune raison d'être opposées puisqu'il existe un troisième corps, le champ, qui contient tout ou partie de l'impulsion échangée lors de l'interaction.

Plus formellement, la relation $\boldsymbol{F}_{12}+\boldsymbol{F}_{21}=0$ provient de la conservation de l'impulsion quand il y a *interaction directe* (ou de contact) entre les deux corps. Ce qui s'écrit aussi

$$\frac{\mathrm{d}\boldsymbol{p}_{21}}{\mathrm{d}t}+\frac{\mathrm{d}\boldsymbol{p}_{12}}{\mathrm{d}t}=0.$$

Dans laquelle $\mathrm{d}\boldsymbol{p}_{21}$ ($\mathrm{d}\boldsymbol{p}_{12}$) symbolise la variation d'impulsion du corps 2 (1) due au corps 1 (2). S'il existe un troisième corps transmettant l'interaction entre les deux premiers, on aura cette fois

$$\frac{\mathrm{d}\boldsymbol{p}_{23}}{\mathrm{d}t}+\frac{\mathrm{d}\boldsymbol{p}_{32}}{\mathrm{d}t}=0 \qquad \frac{\mathrm{d}\boldsymbol{p}_{13}}{\mathrm{d}t}+\frac{\mathrm{d}\boldsymbol{p}_{31}}{\mathrm{d}t}=0$$

d'où en additionnant

$$\frac{\mathrm{d}\boldsymbol{p}_{23}}{\mathrm{d}t}+\frac{\mathrm{d}\boldsymbol{p}_{13}}{\mathrm{d}t}+\frac{\mathrm{d}\boldsymbol{p}_{31}}{\mathrm{d}t}+\frac{\mathrm{d}\boldsymbol{p}_{32}}{\mathrm{d}t}=0$$

il s'ensuit que

$$\frac{\mathrm{d}\boldsymbol{p}_{23}}{\mathrm{d}t}+\frac{\mathrm{d}\boldsymbol{p}_{13}}{\mathrm{d}t}\neq 0$$

ce qui signifie que la force *sur* 1 n'est pas opposée à la force *sur* 2.

Dans son célèbre Cours de Physique, Feynman (1979) a proposé un paradoxe, concernant la conservation du moment angulaire dans une interaction électromagnétique, résolu par ailleurs (Aguirregabiria et Hernandez 1981, Boos 1984, Lombardi 1983). On propose ici un paradoxe analogue, sur un modèle plus simple, concernant la conservation de l'impulsion.

2. Modèle

On sait que les forces magnétiques de Lorentz $q\boldsymbol{v}\times\boldsymbol{B}$ s'exerçant entre deux charges en mouvement ne sont opposées que si leurs vitesses sont parallèles.

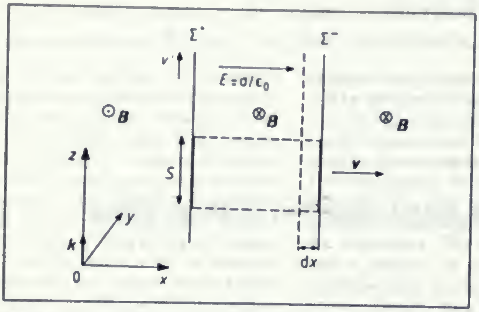

Figure 1

Dans le cas général il n'en est pas ainsi (Lévy-Leblond et Butoli 1983) en violation flagrante avec le PAR. Il est intéressant de noter que c'est à ce propos, ou plus exactement celui de l'interaction des courants, qu'Ampère, 'le Newton de l'électricité', avait introduit une force de répulsion assez mystérieuse entre 'les parties d'un même courant' (Ampère 1958) car il croyait à la validité générale du PAR de Newton (Lévy-Leblond et Butoli 1983).

On considère donc (figure 1) dans un repère $(0, x, y, z)$ deux plans Σ^+ et Σ^- parallèles à $y0z$ de densités de charges respectives σ^+ et σ^- avec $|\sigma^+| = |\sigma^-| = \sigma$ tels que Σ^+ se déplace à une vitesse constante parallèlement à $0z$ et Σ^- à une vitesse v constante parallèlement à $0x$.

Il existe alors un champ électrique parallèle à $0x$ entre Σ^+ et Σ^- de valeur $E = \sigma/\varepsilon_0$, et qui est nul à l'extérieur de ces deux plans. De même il existe un champ magnétique uniforme B, dû au mouvement de Σ^+, qui est antiparallèle à $0y$ dans le demi-espace ne contenant pas Σ^- et parallèle à $0y$ dans l'autre demi-espace. Le champ magnétique dû au mouvement de Σ^- le long de $0x$ est nul par symétrie. Sur un élément de surface S de Σ^- s'exerce donc une force magnétique

$$F_{\Sigma^-} = \mathrm{d}p_{\Sigma^-}/\mathrm{d}t = qv \times B = \sigma^- Sv \times B = -\sigma SvBk$$

qui est antiparallèle à $0z$ (règle des trois doigts . . .). En revanche la force magnétique F_{Σ^+} sur le même élément de surface S de Σ^+ *est nulle* puisque le champ magnétique dû à Σ^- est nul.

'L'action' de Σ^+ sur Σ^- n'est donc pas égale à la 'réaction' de Σ^- sur Σ^+. Il y a une impulsion sur Σ^- mais pas sur Σ^+. Où est-elle donc passée? Nous allons voir qu'elle apparait dans le champ électromagnétique existant entre les deux surfaces S considérées, là où il y a à la fois champ électrique et champ magnétique.

En effet l'impulsion du champ $\mathrm{d}p_{\mathrm{ch}}$ dans le volume $\mathrm{d}V = S\,\mathrm{d}x$ est donnée par

$$\mathrm{d}p_{\mathrm{ch}} = \mathrm{d}V\varepsilon_0 E \times B$$

avec $E \times B = EBk$ et $E = \sigma/\varepsilon_0$, il vient

$$\mathrm{d}p_{\mathrm{ch}} = S\,\mathrm{d}x\,\sigma Bk$$

et, en divisant les deux membres par $\mathrm{d}t$,

$$\mathrm{d}p_{\mathrm{ch}}/\mathrm{d}t = S\,(\mathrm{d}x/\mathrm{d}t)\sigma Bk = Sv\sigma Bk.$$

En comparant avec l'expression de $\mathrm{d}p_{\Sigma^-}/\mathrm{d}t$, on voit que

$$\mathrm{d}p_{\Sigma^-}/\mathrm{d}t = -\,\mathrm{d}p_{\mathrm{ch}}/\mathrm{d}t.$$

C'est donc en fait l'impulsion totale des charges *et* du champ qui est conservée et non pas l'impulsion de Σ^+ et Σ^- seules. Dans le cas général on aura

$$\mathrm{d}p_{\Sigma^+}/\mathrm{d}t + \mathrm{d}p_{\Sigma^-}/\mathrm{d}t + \mathrm{d}p_{\mathrm{ch}}/\mathrm{d}t = 0.$$

Il n'est donc pas étonnant que les forces sur les charges ne vérifient pas le PAR.

3. Remarques

On n'a pas tenu compte des forces électriques entre les deux plans, annulées par des forces mécaniques convenables. On néglige de même le champ électrique du rayonnement de Σ^+ dû à sa mise en marche et qui est de l'ordre de Ev'/c.

Références

Aguirregabiria J M et Hernandez A 1981 *Eur. J. Phys.* **2** 168
Ampère A M 1958 *Théorie Mathématique des Phénomènes Electrodynamiques Uniquement Déduite de l'Expérience* (Paris: Blanchard)
Boos F L 1984 *Am. J. Phys.* **52** 756
Feynman R P 1979 *Electromagnétisme* vol 1 (Paris: InterEditions) p 294
Lévy-Leblond J M et Butoli A 1983 *La Physique en Questions: Electricité et Magnétisme* Q99-Q 105-Q 106 (Paris: Vuibert)
Lombardi G G 1983 *Am. J. Phys.* **51** 213
Ménigaux J 1986 *Bull. Union Physiciens* **683** 762
Viennot L 1982 *Bull. Union Physiciens* **640** 479

ACTION AND REACTION IN ELECTROMAGNETISM (MARINOV'S COMMENTS ON THE PAPER OF A. BUTOLI)

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Abstract. I emphasize once more that only the radiation electromagnetic field has momentum density but the potential electric and magnetic fields have no momentum density. Making reference to the recent paper of Butoli[1], I show that the momentum densities of potential electric and magnetic fields exist only on paper but in the physical reality they do not exist. Thus Newton's third law in electromagnetism is preserved only on paper but in reality it is not preserved, as my Bul-Cub machine without stator has recently patently demonstrated.

Since many years I try to show to the world[2-7] that Newton's third law in electromagnetism can be violated not only at the interaction of single charges and single current elements (as also the conventional theory asserts), but that such violations can be observed also for systems of electric charges and for current loops having condensers with large distances between the plates.

Conventional physics supposes that Newton's third law has an absolute validity and, for saving this law in electromagnetism (at least on the paper), it assumes that the "momentum density" of the potential electric and magnetic fields balances the "unbalanced" momenta which appear at the interaction of the electric charges. Such assumptions of conventional physics are wrong and have no experimental support.

I showed[2,4] that only the radiated electromagnetic field (which is inversely proportional to the first power of the distance from the charges radiating it, whose electric and magnetic intensities are equal, mutually perpendicular and perpendicular to the direction of propagation of the field, and which depends on the acceleration of the charges at the advanced moment $t' = t - r/c$, where t is the observation moment and r is the distance to the radiating charges) has momentum density. The potential electric and magnetic fields (which are inversely proportional to the second power of the distance from the charges generating them and which depend on the charges and their velocities at the observation moment) have no momentum.

Thus it is an idiotism to assert that a permanent magnet producing the magnetic intensity $\mathbf{B}$ and a charged condenser producing the electric intensity $\mathbf{E}$ create an "electromagnetic field" whose momentum density is $(c/4\pi)\mathbf{E}\times\mathbf{B}$. Nevertheless this idiotism is preached in any physics textbook.

I noted (3,7) that Graham and Lahoz(8) first have observed violation of Newton's third law and of the angular momentum conservation law in electromagnetism (and in physics) but they have not understood well their experiment and have supposed that the opposite angular momentum has been "taken" by the "field".

I carried out a variation of Graham and Lahoz' experiment constructing my Bul-Cub machine without stator(3), where a body of 2 kg rotated under the action of "internal" magnetic forces violating thus patently the angular momentum conservation law. The referees of the leading physical journals of the world rejected the publication of my paper with the argument that the opposite angular momentum is "taken" by the "field", however without showing by the help of which physical observations can this huge field angular momentum be detected. My correspondence with the referees and the editors of the physical journals is published in Refs. 3-7 and my Bul-Cub machine without stator still remains practically unknown to the scientific community, as the circulation of my books is limited.

Here I should like to note that Newton has introduced his law not for the interaction of two "bodies" only but for the interaction of any two parts of the interacting bodies, thus, we can say today, for the interaction of any two particles. The introduction of the "field" which has to save the violation of Newton's third law at the magnetic interaction of the particles is a charlatanry completely alien to Newton's spirit.

Recently Butoli(1) has published a short paper which has to show once more that Newton's third law in electromagnetism is conserved. The essence of Butoli's Gedankenexperiment is the following (fig. 1):

In the reference frame Oxyz there are two infinitely large planes Σ^+ and Σ^- (Butoli forgets to add the word "infinitely") parallel to the yz-plane, respectively charged with the charge densities σ^+ and σ^-, where $|\sigma^+| = |\sigma^-| = \sigma$. The plane Σ^+ moves with a constant velocity v in parallel to the z-axis, while the plane Σ^- moves with the same velocity v in parallel to the x-axis.

The magnetic intensity, **B**, produced by the plane Σ^+, must be anti-parallel to Oy in the space to the left of it and parallel to Oy in the space to the right of it. Now I shall give the demonstration of this assertion.

Assuming that Σ^+ coincides with the yz-plane, we shall have for the magnetic potential generated by the elementary surface ds with coordinates (0, y, z), denoting by r the distance from ds to an arbitrary point on the x-axis whose abscissa is x,

$$d\mathbf{A} = \sigma ds \mathbf{v}/cr = \sigma\, dy\, dz\, v\hat{\mathbf{z}}/c(x^2+y^2+z^2)^{1/2}. \quad (1)$$

For the magnetic potential generated by the whole plane we obtain

$$\mathbf{A} = 4\int_0^\infty\int_0^\infty \sigma v\, dy\, dz\, \hat{\mathbf{z}}/c(x^2+y^2+z^2)^{1/2} = f(x)\hat{\mathbf{z}}, \quad (2)$$

as, obviously, **A** will not depend on y and z. Thus

$$\mathbf{B} = \mathrm{rot}\mathbf{A} = -\ \hat{z}\times \mathrm{grad}f(x) = -\ \hat{z}\times\{\partial f(x)/\partial x\}\hat{\mathbf{x}} = -\ \{\partial f(x)/\partial x\}\hat{y}, \qquad (3)$$

where $\partial f(x)/\partial x < 0$ for $x > 0$ and $\partial f(x)/\partial x > 0$ for $x < 0$.

In a similar way we establish that the magnetic intensity produced by the motion of plane Σ^- is zero in the whole space.

Butoli shows that the plane Σ^- acquires momentum along the negative direction of the z-axis, while the momentum of the plane Σ^+ remains unchanged. And Butoli shows that the "momentum" of the electromagnetic field increases with a quantity exactly equal and opposite to the momentum acquired by the ponderable masses of the system.

The momentum of the "field" increases but this momentum can by no technical means be detected. Thus the momentum of the electromagnetic field exists only on paper. In the physical reality it does not exist. On the contrary, the momentum of the radiated electromagnetic waves exists in the physical reality and can physically be detected.

Consequently I can accept that one ascribes a "momentum density" $\mathbf{\Pi} = (c/4\pi)\mathbf{E}\times\mathbf{B}$ to potential electric and magnetic fields; but only in the way in which I accept the existance of ghosts of dead persons.

REFERENCES

1. A. Butoli, Europ. J. Phys., **10**, 59 (1989).
2. S. Marinov, Classical Physics (East-West, Graz, 1981).
3. S. Marinov, The Thorny Way of Truth, Part III (East-West, Graz, 1988).
4. S. Marinov, The Thorny Way of Truth, Part IV (East-West, Graz, 1989).
5. S. Marinov, The Thorny Way of Truth, Part V (East-West, Graz, 1989).
6. S. Marinov, The Thorny Way of Truth, Part VI (East-West, Graz, 1989).
7. S. Marinov, The Thorny Way of Truth, Part VII (East-West, Graz, 1989).
8. G. M. Graham and D. G. Lahoz, Nature, **285**, 154 (1980).

FIGURE CAPTION

Fig. 1. Butoli's Gedankenexperiment.

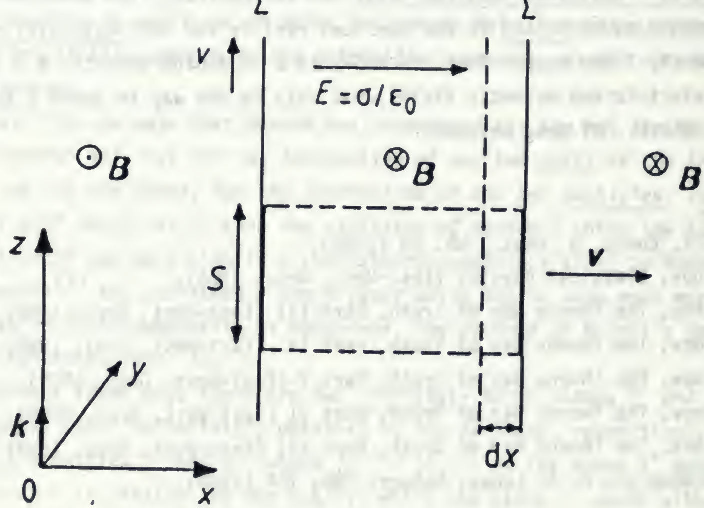

Fig. 1

CALCULATION OF THE PUSHING FORCE WHICH ACTS ON THE AMPERE BRIDGE

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Abstract. The calculation of the pushing force which acts on the classical Π-form Ampere bridge leads to unlimited integrals, as the force at the edges of the bridge becomes infinitely big. To be able to make an exact calculation of this pushing force, I exchanged the linear shoulder by a half-circular. The pushing force on such a U-form Ampere bridge (U tipped over), which is always less than on the traditional Π-form bridge, can easily be calculated if certain approximation should be introduced. The value obtained gives the lower limit of the force which I have measured with my Π-form bridge (the first such measurements have been done by Pappas). For a reliable experimental verification of Grassmann's theory (sustained by me) about the forces acting on the Ampere bridge, careful and precise measurements are to be done with U-form Ampere bridges.

I have calculated in Ref. 1 the pushing force which acts on a Π-form Ampere bridge with length L of the legs and length a of the shoulder, along which current I flows, obtaining

$$f = (\mu_o I^2/2\pi)\int_{a_o}^{a} L(x^2+L^2)^{-1/2}(dx/x) \cong (\mu_o I^2/2\pi)\int_{a_o}^{a} dx/x = (\mu_o I^2/2\pi)\ln(a/a_o), \qquad (1)$$

where for a bridge with $a/L < 0.33$ the approximation in (1) leads to an error not bigger than 5%. The quantity a_o is very small but nevertheless different from zero because for $a_o = 0$, as it must be for the idealized mathematical case, the force becomes infinitely big, a case which, of course, in physics cannot exist.

If we take $I = 1$ A, $a_o = e^{-25}a = 1.4\times10^{-11}a$, and if we remember that $\mu_o = 4\pi 10^{-7}$ N/A^2, we obtain

$$f = \alpha \equiv 5\times10^{-6}\ \mathrm{N/A^2}. \qquad (2)$$

I called such a force a force-factor of the normal Ampere bridge* and denoted it by α. My measurements[1,2] showed that the pushing force acting on the Π-form Ampere bridge used by me, where the full edge forces have been included, for $I = 1$ A, was quasi equal to the force-factor of the normal Ampere bridge. In Pappas' experiments[3] the edge effects have been excluded and he measured forces 5 times weaker[4].

*It would be more convenient to choose the force factor of the normal bridge $\alpha = 10^{-6}$ N/A

To be able to make exact calculation of the pushing force on the Ampere bridge, I took the bridge not in the traditional Π-form but in a U-form which can be seen in fig.

The force with which a current element $I\mathbf{dr}'$ acts on another current element $I\mathbf{dr}$, according to Grassmann's formula[4] is

$$df = (\mu_0/4\pi)I^2\mathbf{dr}\times(\mathbf{dr}'\times\mathbf{r})/r^3 = 10^{-7}\, I^2\{\mathbf{dr}'(\mathbf{dr}.\mathbf{r}) - \mathbf{r}(\mathbf{dr}.\mathbf{dr}')\}/r^3, \quad (3)$$

where $\mathbf{r}$ is the oriented distance from $\mathbf{dr}'$ to $\mathbf{dr}$.

First let us calculate the force with which the currents in both legs act on the current in the half-circular shoulder. Let us assume that the radius of the half-circle is R and the legs are infinitely long (fig. 1)

Taking the linear element $\mathbf{dr}'$ along the left leg and the linear element $\mathbf{dr}$ along the half-circular shoulder, we shall obtain for the elementary <u>pushing Ampere force</u> which is the component of the global force acting along direction parallel to the legs, as the component acting in direction perpendicular to the legs is zero, for I = 1 A,

$$df_A = 10^{-7}\,\frac{dr_\parallel'(dr_\parallel r_\parallel + dr_\perp r_\perp) - r_\parallel(dr_\parallel dr_\parallel' + dr_\perp dr_\perp')}{(r_\parallel^2 + r_\perp^2)^{3/2}}, \quad (4)$$

where $dr_\parallel$, $dr_\parallel'$ are the components of $\mathbf{dr}$ and $\mathbf{dr}'$ <u>parallel</u> to the legs, $dr_\perp$, $dr_\perp'$ are the components <u>perpendicular</u> to the legs, and, similarly, $r_\parallel$ and $r_\perp$ are the parallel and perpendicular components of $\mathbf{r}$.

We have

$$\begin{aligned} &dr = Rd\beta, && dr_\parallel = R\cos\beta\, d\beta, && dr_\perp = R\sin\beta\, d\beta, \\ &dr' = (R/\cos\alpha)d\alpha, && dr_\parallel' = Rd\alpha/\cos^2\alpha, && dr_\perp' = 0, \\ &r_\parallel = R\sin\beta + R\tan\alpha, && && r_\perp = R - R\cos\beta. \end{aligned} \quad (5)$$

Putting (5) into (4), integrating for $0 < \alpha < \pi/2$, $0 < \beta < \pi$, and taking into account that there are two legs, we obtain

$$f_A' = 2\times10^{-7}\int_0^{\pi/2}\int_0^{\pi}\frac{\cos\alpha\sin\beta(1 - \cos\beta)\, d\alpha\, d\beta}{(1 + 2\sin\alpha\cos\alpha\sin\beta - 2\cos^2\alpha\cos\beta + \cos^2\alpha)^{3/2}}, \quad (6)$$

and we thus see that the pushing force acting on a U-form Ampere bridge does not depend on the radius R of the half-circular shoulder.

The calculation of the integral (6) is difficult and Dr. Rainer Feldbacher (Physical Institute of the Technical University, Graz), to whom I express my cordial thanks, carried out the calculation on a computer, obtaining the value

$$f'_A = 0.1222\ \mu N/A^2. \tag{7}$$

Now I shall calculate the pushing force acting on the half-circular shoulder and caused by the potential action <u>of</u> the current elements in the shoulder <u>on</u> the current elements of the shoulder. Let me note that for the Π-form Ampere bridge the force acting on the current elements of the shoulder and caused by the potential action of the current elements in the shoulder is equal to zero, as all these current elements are colinear and for colinear current elements the magnetic force, according to Grassmann's formula, is zero.

Taking the current elements Idr' and Idr at two arbitrary positions on the half-circle, we shall have the following expressions for $dr_\parallel$, $dr_\perp$, $dr'_\parallel$, $dr'_\perp$, $r_\parallel$, $r_\perp$, which we have to put in formula (4) and integrate it for $0 < \alpha < \pi$, $0 < \beta < \pi$,

$$\begin{aligned} &dr = Rd\beta, && dr_\parallel = dr\cos\beta = R\cos\beta\, d\beta, && dr_\perp = dr\sin\beta = R\sin\beta\, d\beta, \\ &dr' = Rd\alpha, && dr'_\parallel = dr'\cos\alpha = R\cos\alpha\, d\alpha, && dr_\perp = dr'\sin\alpha = R\sin\alpha\, d\alpha, \\ & & r_\parallel = R(\sin\beta - \sin\alpha), & & r_\perp = R(\cos\alpha - \cos\beta). \end{aligned} \tag{8}$$

Dividing the domain of integration in four domains, we shall have

$$f''_A = \int_0^\pi\int_0^\pi = \int_0^{\pi/2}\int_0^{\pi/2} + \int_0^{\pi/2}\int_{\pi/2}^{\pi} + \int_{\pi/2}^{\pi}\int_0^{\pi/2} + \int_{\pi/2}^{\pi}\int_{\pi/2}^{\pi} = 2\int_0^{\pi/2}\int_0^{\pi/2} + 2\int_0^{\pi/2}\int_{\pi/2}^{\pi} =$$

$$2\times10^{-7}\int_0^{\pi/2}\int_0^{\pi/2}\frac{\cos\alpha\{\cos\beta(\sin\beta-\sin\alpha)+\sin\beta(\cos\alpha-\cos\beta)\}-(\sin\beta-\sin\alpha)(\cos\alpha\cos\beta+\sin\alpha\sin\beta)}{\{(\sin\beta-\sin\alpha)^2+(\cos\alpha-\cos\beta)^2\}^{3/2}}d\alpha d\beta$$

$$\cdot\ 2\times10^{-7}\int_0^{\pi/2}\int_0^{\pi/2}\frac{\cos\alpha\{-\cos\beta(\sin\beta-\sin\alpha)+\sin\beta(\cos\alpha+\cos\beta)\}-(\sin\beta-\sin\alpha)(-\cos\alpha\cos\beta+\sin\alpha\sin\beta)}{\{(\sin\beta-\sin\alpha)^2+(\cos\alpha+\cos\beta)^2\}^{3/2}}d\alpha d\beta$$

$$= (10^{-7}/\sqrt{2})\int_0^{\pi/2}\int_0^{\pi/2}\frac{\sin\beta\, d\alpha\, d\beta}{\{1-\cos(\alpha-\beta)\}^{1/2}} + (10^{-7}/\sqrt{2})\int_0^{\pi/2}\int_0^{\pi/2}\frac{\sin\beta\, d\alpha\, d\beta}{\{1+\cos(\alpha+\beta)\}^{1/2}}\ . \tag{9}$$

These two integrals cannot be taken. The second integral can be calculated on a computor, but the first can be not, as it has peculiarities for $\alpha = \beta$. I was <u>unable</u> to find a way for calculating the first integral and I leave this task to whom is more skilled in mathematics. I am, however, afraid that the first integral is <u>unlimited</u>. This is a very <u>strange</u> result, as the force between two infinitely near and <u>colinear</u>

current elements must be zero. Formula (9) shows that for $\alpha = \beta$ the integrand in the first integral (9), i.e., the elementary force, is unlimited and thus the integral is improper. But the value of an improper integral may be limited. As said above, I leave the solution of this problem to people more skilled in mathematics. I consider the strange result that the first integral may become unlimited, because the denominator of the elementary force tends to zero more quicker than the nominator, as a wrong mathematical presentation of the physical reality. I liberated the first integral of this mathematical absurdity by making the calculation in the following approximate way:

As the distance r between both current elements varies from 0 to 2R, I took R as some average value and I presented $r^3 = (r_{\parallel}^2 + r_{\perp}^2)^{3/2}$ as $r^3 = Rr^2 = R(r_{\parallel}^2 + r_{\perp}^2)$. At such an approximation the integrals in (9) obtain very simple forms and can immediately be taken

$$f''_A \geq \sqrt{2}\times 10^{-7} \int_0^{\pi/2}\int_0^{\pi/2} \sin\beta \, d\alpha \, d\beta = \pi 10^{-7}/\sqrt{2} = 0.2221 \ \mu N/A^2. \quad (10)$$

Thus if taking into account (7) and (10), we obtain for the net pushing force acting on a U-form Ampere bridge the following value, emphasizing that we could take R above multiplied by any number smaller than 2,

$$f_A \geq f'_A + f''_A = 0.3443 \ \mu N/A^2. \quad (11)$$

With my Π-form Ampere bridge I measured forces 10 times bigger. Here I would like to note that if the edges of the Π-form bridge will be considered as half circles with radius $R = 1.4\times 10^{-11}a$, where a is the length of the shoulder, then the force acting on these half circles will be about the half of (11) and the force acting on the shoulder will be equal to $\alpha = 5 \ \mu N/A^2$ (see fromulas (1) and (2)).

All above calculations are valid, of course, for an infinitely thin wire.

REFERENCES

1. S. Marinov, The Thorny Way of Truth, vol. IV, p. 136 (East-West, Graz, 1989).

2. S. Marinov, The Thorny Way of Truth, vol. III, p. 95 (East-West, Graz, 1988).

3. P. G. Moyssides and P. T. Pappas, J. Appl. Phys., 59, 19 (1986).

4. S. Marinov, The Thorny Way of Truth, vol. II, p. 82 (East-West, Graz, 1986).

FIGURE CAPTIONS

Fig. 1. - U-form Ampere bridge.

Fig. 2. - Half-circular shoulder of a U-form Ampere bridge.

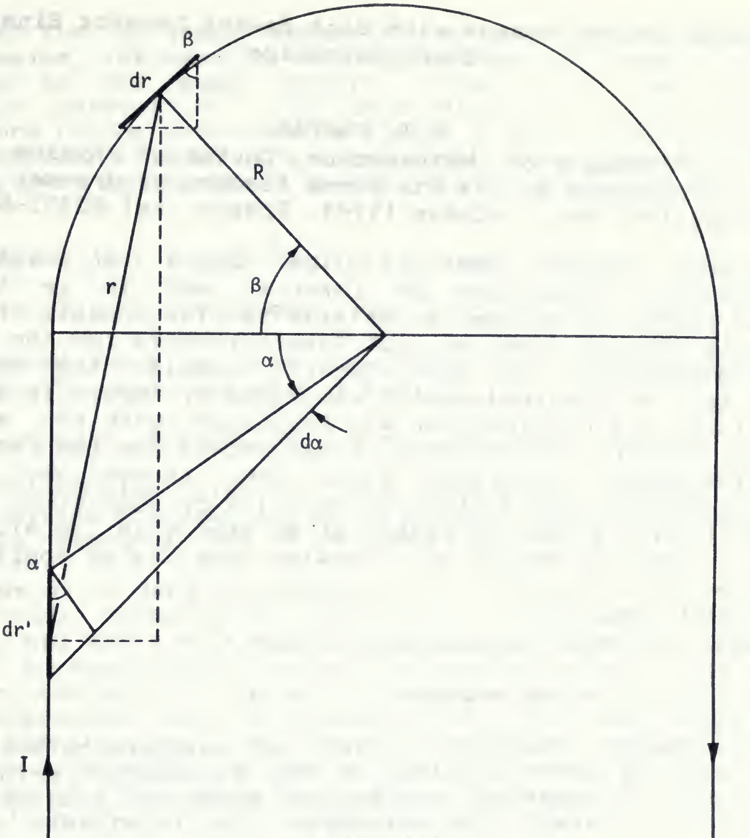

Fig. 1

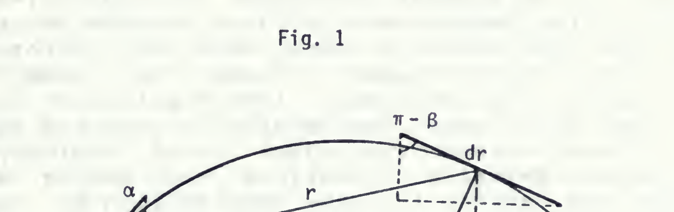

Fig. 2

Contradicting Physics with Biot Savart Lorentz Einstein Electrodynamics

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The Lorentz force law is the basis of relativistic electrodynamics, developed by Lorentz; and it is the major invariant force law of Special Relativity. The Lorentz force law is actually derived from the Biot Savart formula for the magnetic field. Contemporary to Biot Savart formula, the so called cardinal law of Electrodynamics was found by Ampere in the years 1821 to 1825. The cardinal law was forgotten with the advent of Relativity Theory. Its assumed disadvantage was the fact it was not a relativistic invariant force law, though not a single experiment was found to falsify this law by that time, nor one has been found yet. Nevertheless, often when this infallible law is used to explain easily an otherwise complicated configuration of electrodynamic forces, it is pointed out that it is equivalent to the Lorentz law.

However, the relativistic Lorentz law:

$$F = q(E + V \times B/c) \qquad 1.$$

does not respect Newton's action and reaction between moving charges. This implies violation of the fundamental principle of conservation of momentum and angular momentum. However, Nature seems always to respect this principle. So, Physicists made the hypothesis that the Relativistic law should always be supplemented (see for example reference 1, page 541-542), by a contribution of the Electromagnetic field via the Poynting vector to overcome this deficiency. A more advanced approach of this hypothesis in microphysics leads to modern Quantum Electrodynamics(1). The origin of this hypothesis goes back to Maxwell(2), who first made the hypothesis that his displacement current is in every respect equivalent to an ordinary material current. Using Maxwells equations and making appropriate manipulations, one can see that the contribution of the Poynting vector is another expression of Maxwells original hypothesis for the equivalence of a displacement current with an ordinary current. These hypotheses are equivalent to saying that there are no moving charges that do not belong the same time to an assumed closed circuit- possibly closed by a displacement current. This was also pointed by Maxwell(2) page 163, art 501, who emphasized that in practice there are no open circuits. Early enough, Ampere himself had shown that his law and the derived force from the Biot and Savart formula are identical for closed and separated circuits. Consequently, Maxwells hypothesis leads to the assumption that the cardinal law and the Lorentz law are equivalent for at least separately moving charges or currents. There remains the case for the equivalence of forces for charges belonging to the same circuit. This is a case of current scientific debate[3-12]. In this author's opinion, neither the equivalence of the last case is always correct, nor all circuits are effectively closed. The last point is a main point of the present paper, and we shall investigate it below for a particular case.

The cardinal law in its original electric current form reads,

$$F_{12} = -r_{12}I_1I_2/r_{12}^3(2ds_1 \cdot ds_2 - 3/r_{12}^2(ds_1 \cdot r_{12})(ds_2 \cdot r_{12})) \quad 2.$$

The updated form of the Cardinal law, corresponding to the Lorentz relativistic law should read[5],

$$F_{12} = -r_{12}q_1q_2/r_{12}^2(2v_1 \cdot v_2/c^2 - 3/c^2r_{12}^2(v_1 \cdot r_{12})(v_2 \cdot r_{12}) - 1) \quad 3.$$

This is the cardinal law in its charge to charge form, for discreet moving charges, and it is derived from the original form using the identity ids = qv and including the Coulombic* interaction.

A rigorous revision by the author of the major experimental evidence, had shown that there is a serious number of experiments that the Lorentz force law can not explain at all; and leads to erroneous conclusions, though the cardinal law is always straight forward applicable and in agreement with the observation. Such a case is the experiment by Graham and Lahoz, Nature, 285, 154, 1980; the Cemented Faraday Disc; Several of the Hering Experiments in 1923, Trans. Am. Inst. El. Eng. 42, 311; and an accountable number of other experiments[14-24].

The Graham and Lahoz experiment consists of charging and discharging continuously with an alternating current, a cylindrical capacitor suspended with its axis vertically by a torsion wire and connecting its plates to an alternating current source as shown in diagram 1. The current flows in two unequal radii making an angle of 180 degrees. These two unequal radii are in an axial magnetic field, formed by a coil placed in such a way that its axis coincides with the axis of the capacitor. The coil is fixed in the laboratory and it is also fed with the same alternating current source, so that the forces on the currents on the two unequal radii,

$$F_1 = IBR_1 \quad \text{and} \quad F_2 = IBR_2 \quad 4.$$

are always in the same relative direction.

As a result a resultant torque with respect to the axis is exercised on the capacitor:

$$N = IBR_1(R_1/2) - IBR_2(R_2/2) = IB(R^2{}_1-R^2{}_2)/2 \quad 5.^{**}$$

This torque was observed by Graham and Lahoz from the deflection

*Coulomb **This formula must be obtained by integration (see, for example, formula (4) on p. 139 of TWT-IV) of the torsion wire monitored by a reflecting mirror. Graham and Lahoz explained this result as follows: "Although this result is to be expected by Classical Electrodynamics* it leads inexorably to the acceptance of the physical reality of the pointing** vector, even though **E** and **H** arise from independent sources. This can be seen by seeking the system on which the third law reaction torque must act. It can be neither the external electrical circuit, as the loop is essentially closed within the suspension, nor in the magnet, which as a coil, cannot receive an axial torque (force parallel to its own current)....the calculated torque is exactly equal to the volume integral of $r \times d(E \times H)/dtc^2$, so that the complete reaction is accounted for by the assignment of a real angular momentum density to $r \times (E \times H)/c^2$". Obviously, the interpretation of G/L is based exclusively on the Lorentz law, since the cardinal law readily produces a reaction force parallel to the current of the coil.

The G/L experiment essentially consists of a materially open circuit, which is closed by a capacitor gap. Inside the capacitor gap, there is a displacement current proportional to dE/dt and numerically equal to the outside material current; as well as it is numerically equal to the change of the integral of the poynting vector. However, the observation of G/L as well as their interpretation directly points out that the role of the poynting vector or the role of the displacement current is not the assumed one. If the displacement current was completely equivalent to the rest of the material current, then Graham and Lahoz circuit would be equivalent to a solid and trivial closed circuit without effectively a capacitor gap. For the case of a solid circuit, the forces between it and the coil are equal and opposite. However, the force on a coil from a closed circuit is always radial toward the axis. Thus the force on the solid and closed circuit, being opposite in direction to that of the coil, would be also radial toward the axis, according to both laws. However, such a radial force produces no torque and no rotation. Therefore, the observed rotation by G/L proves that, either considering the cardinal law or considering the Lorentz law, and no matter what is the role of the displacement current or the role of the poynting vector, the circuit of G/L is not equivalent to a closed circuit. The interpretation of G/L for the role of the poynting vector is the exact opposite than Maxwell's hypothesis. The displacement current, instead of compensating the unexpected for a closed circuit torque, is assumed to be the agent that takes up the reaction of a real and operating torque.

Thus, the observation of G/L modifies the assumed hypothesis of Maxwell for the equivalence of any circuit to a closed circuit, via his displacement current. At this point I would like to make clear, without providing the necessary calculations, that the cardinal law provides the same numerical value for the observed torque without any kind of extra assumptions, and the same time, it places the reaction force and the reaction torque naturally on the causing the force agent, i.e. tangently on the coil.

*electromagnetism **Poynting

Unfortunately, G/L never considered this natural explanation provided by the cardinal law and they never searched for the reacting force on their coil(22).

However, let us over look the natural explanation of the cardinal law and search the consequences of the only possible interpretation of G/L according to the relativistic Lorentz law.

The observed by G/L torque on the suspended circuit according to Lorentz law as well as according to the cardinal law is given numerically by equation 5, within the experimental error. This is also the value given directly by the measurement. So, there is nothing to say at this point. However, the reaction of this torque according to the relativistic law, as explained by G/L should be expected to be taken up by the poynting vector and exercised on the vacuum. Numerically the reaction is:

$$N = r \times F = r \times (dP/dt) = \int_{\text{vol. of gap}} \{d(E \times H)/dtc^2\}dv \qquad 6.$$

Where
$$P = \int_{\text{vol. of gap}} (E \times H)/c^2 dv = \qquad 7.$$

E and H are uniform inside the capacitor gap. Therefore, integral 7 is equal to:

$$P = EHV/c^2 \qquad 8.$$

Where V is the volume of the capacitor gap.

According to the data given by G/L it is:
R_1 = 5.5 mm,
R_2 = 4.5 mm,
h = 15 mm,
C_o = 5 pf,
E = 2.3 MV/m,
Voltage = 2KV
e_o = 8.855x10-12cb/vm

Volume of capacitor gap = $(R_2^2 - R_1^2)h^*$ = 471 mm^3 = 471×10^{-9} m^3

$P = 2.3 \times 10^6 \times 0.22 \times 10^7 \times 471 \times 10^{-9} / (4\ 3^2 10^{16})^{**}$ Ntsec = $19/(3^2 10^{16})$ Ntsec

This is the momentum deposited into the vacuum per cycle.
To this electromagnetic momentum, there corresponds an energy given by special relativity (see Philips and Panofski(23), page 184, lines 5-10), i.e.

$$E = (m_o^2c^4 + p^2c^2)^{1/2} = pc = 19/(3 \times 10^8) \text{ Ntm} = 64 \times 10^{-5} \text{ Joules},$$

continuously stored into the vacuum.
This is an enormous loss of energy into the vacuum. Indeed, it is clear that the angular momentum gain per cycle is additive, due

$^*\pi(R_2^2 - R_1^2)h$ $\qquad$ $^{**}4\pi 3^2 10^{16}$

to the simultaneous reversal of both E and H, so the deposited into the vacuum angular momentum is, and so the deposited into the vacuum energy is. This is contrary to an ordinary process of charging and discharging of electrical energy into a capacitor; or similarly to storing magnetic energy in a magnetic field and to retrieving it back when the magnetic field is switched off. To compare this loss, we calculate the periodic storing and retrieving electrostatic energy in the G/L capacitor. It is

$$E = 1/2\ CV^2 = 1/2 \times 5 \times 10^{-12} pf \times 2^2 \times 10^6 V^2 = 1 \times 10^{-5}\ \text{Joules}.$$

The energy stored into the vacuum during 64 cycles in the unique interpretation of the Lorentz force is the same as the electrostatic energy charged and discharged into the capacitor. The energy stored into the vacuum is apparently not retrievable, and it is as big as long the experiment lasts and as much as one wishes. Vacuum in this way seems to interfere to otherwise assumed isolated systems. Conservation of energy and angular momentum of an isolated system seems to be invalidated by the vacuum. These are absolutely impossible assumptions and should be excluded, as contrasted to the natural and straight forward description, offered to the observed torque, by the cardinal law of electrodynamics, without assigning bizarre properties to the vacuum and not violating fundamental conservation laws.

A similar experiment to G/L, but concerning the linear momentum was performed by Pappas[3] and repeated by Graneau et al[12]. The explanation of it, according to the cardinal law, was also natural. On the contrary, an explanation according to the Lorentz law and with the assumed reaction to be applied into the field[3,12], led similarly to paradoxical results. Further, experimentation of the suspended pi-frame had shown in various ways that the reaction goes into the mercury cups as expected by the cardinal law, and that the force is much dependent on various parameters inside this cups, in general, being smaller, up to 40%, than the Lorentz force, which is independent on such parameters, depending only on the length of the pi-frame bridge and the magnetic field around it. This result is absolutely compatible to the cardinal law for the electrodynamic force[4,5].

The assumed disadvantage of the cardinal law, not being relativistic, can not withstand its simplicity and unique compatibility to vast experimental decisive evidence. The unjustly forgotten law of electrodynamics, in this author's opinion, will take eventually back its position, proving also the assumed disadvantage, as a matter of fact, to be a precious and operating advantage[24,25].

REFERENCES.

1 M. Alonso, E.J. Finn, "Fundamental University Physics", VII,

Addison Wesley, Reading Ma, 1978.
2. J.C. Maxwell, "A treatise on Electricity and Magnetism", v2, Dover, New York, 1954.
3. P.T. Pappas, Nuovo Cimento 76B, 189, 1983
4. P.T. Pappas, "The Cardinal Law of Electrodynamics and Relativity", to be published.
5. P.T.* "On the Non Equivalence of Ampere and Lorentz Force Laws; and Longitudinal Contact Forces", to be published.
6. P.T. Pappas and P.G. Moyssides, Phys. Lett. 111A, 4, 193, 1985; P.G. Moyssides and P.T. Pappas, J. Appl. Phys., 59(1), 19, 1986.
7. J.G. Ternan, J. Appl. Phys. 57,1743, 1985.
8. J.G. Ternan, Phys. Lett.A,115,5,230,1986.
9. D.C. Joly, Phys. Lett. A 107, 231, 1985.
10. C. Christodoulides, Phys. Lett. A 120,129,1987; J.Phys. A: Math.Gen. 20,2037,1987.
11. P.T. Pappas, "The Ampere Law and the Theory of Relativity",1987, to be published.
12. P. Graneau and P.N. Graneau, Nuov. Cim. 7D, 31,1986.
13. G.M. Graham and D.G. Lahoz, Nature, 285, 154, 1980.
14. C. Hering, Trans. Am. Inst. El. Eng. 42, 311, 1923.
15. P. Graneau, "Ampere Neumann Electrodynamics of Metallic Conductors", Hadronic Press, Nonantum, 1985.
16. P. Graneau and P.N. Graneau, Appl.Phys.Lett.46,5,468,1985.
17. L.Dragone, J.Appl. Phys. 62(8), 3477, 1987.
18. P.T. Pappas, "Measurements of water arc explosions", at Francis Bitter National Laboratory, MIT, 1985, unpublished.
19. L.J. Ruscak and R.N. Bruce, IEEE Trans. on Plasma Sc., ps-15, 1,51, 1987.
20. J. Nasilowski, Przeglad Electrotechniczny (Poland), 37, 10, 397, 1961; IEEE Trans. on Man., MAG.-20, 2158, 1984; "Unduloids and striated disintegrations of wires in "Explosion wires", ed. W.G. Chase, H.H. Moore, v.3, Plenum, New York, 1964.
21. C. Brown, Electronic Engin. Times, p. 58, Sept. 14, 1987; Electronic Engin. Times, p.37., Aug. 31, 1987.
22. S. Marinov, private communication, 1988.
23. W.K.H. Panofski and M. Philips, "Classical Electricity and Magnetism", Addison-Wesley, Reading Ma., 1975.
24. P.T. Pappas, "The Cardinal Law of Electrodynamics and the Principle of Conservation of Energy", 1988, to be published.
25. P.T. Pappas, "The Cardinal Law of Electrodynamics and the Tesla Magnifying Effect", 1988, to be published.

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FIGURE CAPTION

Rotation of a cylindrical capacitor suspended vertically by a torsion wire through its axis (not shown).

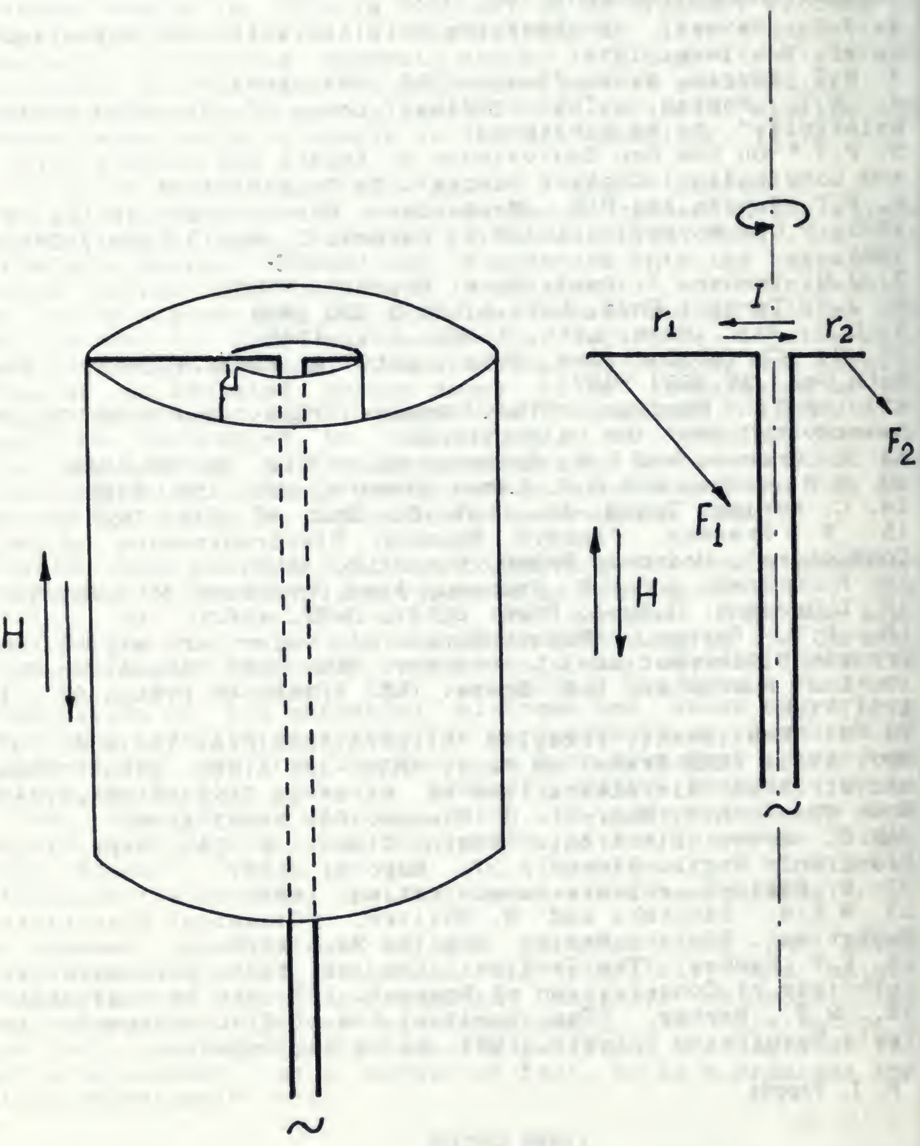

Figure to Pappas' Paper

MARINOV'S COMMENTS ON THE PREVIOUS PAPER BY P. T. PAPPAS

The criticism of Pappas to the Graham + Lahoz (G+L) interpretation about the "absorption" of the opposite angular momentum in the G+L experiment (see the paper of G+L in TWT-III, p. 159) by the "inductive electromagnetic field" is right and I share Pappas' criticism, although I must add that, because of his eternal haste, Pappas works with badly written formulas, makes computational errors and the reader becomes embarassed when checking them. This is due not only to Pappas' eternal haste. Substantial guilt have also the "Maxwellian" concepts which create a terrible mess, and some errors in the formulas written by G+L.

I shall explain all subtle aspects of the G+L experiment, as it is an extremely important experiment (the first one in history where violation of angular momentum conservation law has been observed) and its wrong treatment presented by G+L must be put on the pillory.

According to the Maxwell's concepts, the so-called displacement current with density

$$\mathbf{J}_d = (1/4\pi)\partial\mathbf{E}/\partial t \qquad (1)$$

flows between the plates of a condenser, where

$$\mathbf{E} = -\,\mathrm{grad}U \qquad (2)$$

is the electric intensity between the condenser's plates and U is the electric tension applied to the plates.

According to Maxwell and his followers (almost all contemporary physicists are Maxwell's followers), the displacement current has exactly the same magnetic properties as the conduction current, namely it generates its own magnetic potential (i.e., acts with magnetic potential forces on other currents communicating them kinetic forces) and reacts with kinetic forces to other magnetic potentials. It remains an enigma, how the vacuum between the plates of a condenser can demonstrate kinetic forces, as kinetic forces can be demonstrated only by masses, meanwhile vacuum has no mass.

Here the labyrinth of the speculations of the Maxwellians does begin. The Maxwellians say that if in a certain space domain there is an electric intensity **E** and a magnetic intensity **B**, then this space domain has momentum with density

$$\mathbf{\Pi} = (1/4\pi c)\mathbf{E}\times\mathbf{B}, \qquad (3)$$

representing proper mass with density μ_0 propagating with the velocity c along the direction $\mathbf{n} = \mathbf{E}\times\mathbf{B}/EB\sin\theta$, where θ is the angle between **E** and **B**, so that

$$\mu_0 = |\mathbf{\Pi}|/c = |\mathbf{E}\times\mathbf{B}|/4\pi c^2 . \qquad (4)$$

The "oriented" energy density $\varepsilon = \mu_0 c^2$ is called Poynting vector and is denoted by

$$\mathbf{S} = \varepsilon\mathbf{n} = (1/4\pi)\mathbf{E}\times\mathbf{B}. \qquad (5)$$

As energy density and mass density, according to the relation

$$\varepsilon = \mu c^2/(1 - v^2/c^2)^{1/2} = \mu_0 c^2, \qquad (6)$$

where v is the velocity of the masses, are two different names (with different dimensions of the same entity (I work in my theory with formula (6) and it is MY view-point that energy and mass are two different names of the same entity), the Maxwellians assert that a space domain with S different from zero has mass, but as this mass is moving with a velocity c, it is infinitely small (only in such a case the relation $\mu/(1 - v^2/c^2)^{1/2}$ will be a finite quantity). Thus, according to the Maxwellians, if in a certain space domain filled with vacuum the Poynting vector **S** is different from zero, this space domain has mass and consequently can demonstrate the availability of kinetic forces.

Hence if the G+L cylindrical condenser, between whose plates displacement current with density (1) flows, is put in the magnetic field with intensity **B** of a cylindrical coil, then, according to the Lorentz equation (1) in Pappas' paper, on the vacuum between the condenser's plates the magnetic potential force

$$\mathbf{F} = (1/c)\int_V \mathbf{J}_d\times\mathbf{B}\,dV = (1/4\pi c)\int_V (\partial\mathbf{E}/\partial t)\times\mathbf{B}\,dV \qquad (7)$$

will act. As the vacuum can be not accelerated, the Maxwellians make the unlawful mathematical acrobatics by writing formula (7) as follows

$$\mathbf{F} \equiv (1/4\pi c)\int_V (\partial\mathbf{E}/\partial t)\times\mathbf{B}\,dV = (1/4\pi c)\int_V \partial/\partial t(\mathbf{E}\times\mathbf{B})dV \equiv (\mathbf{n}/c)\int_V (\partial\varepsilon/\partial t)dV \equiv \mathbf{f} \qquad (8)$$

and consider the time variation of the Poynting vector, multiplied by the volume between the condenser's plates and divided by c, as a kinetic force **f** with which the "electromagnetic field" reacts to the action of the potential force **F**.

Note. G+L begin to write the formulas in their article in the system SI. Then they write the formula for the time change of the angular momentum density in the form

$$\partial\mathbf{\Lambda}/\partial t = (1/c^2)\mathbf{r}\times\partial(\mathbf{E}\times\mathbf{B})/\partial t, \qquad (9)$$

while they write the formula for the angular momentum density in the form

$$\mathbf{\Lambda} = c^2\mathbf{r}\times(\mathbf{E}\times\mathbf{B}), \qquad (10)$$

using for **B** the symbol **H**. The last two formulas seem to be written in the system CGS, but both of them are wrong, as in the system CGS the formula for the density of the angular momentum is

$$\mathbf{\Lambda} = (1/4\pi c)\mathbf{r}\times(\mathbf{E}\times\mathbf{B}). \qquad (11)$$

According to my concepts (see my CLASSICAL PHYSICS, vol. V, §37, or TWT-IV, p. 68), the potential electric and magnetic intensities have no Poynting vector and can be not unified in a vector product having some physical essence. Poynting vector (and respectively, momentum density) can have only the radiation electric and magnetic intensities which are generated by the accelerated motion of any electric charge. In the

G+L experiment the radiated intensities are so feeble that they can be neglected and we have to consider only the potential electric intensity generated by the charges on the plates of the condenser and the potential magnetic intensity generated by the current in the coil. They are intensities generated by two different systems of charges and it is an idiotism to unify them in a Poynting vector as G+L do, noting that the radiation electric and magnetic intensities are always generated by the same charges.

Pappas tries to calculate the momentum in the G+L experiment "deposited into the vacuum per cycle".

First in the experiment of G+L one has to "deposit" not momentum but angular momentum, as the angular momentum acquired by the mass of the rotating condenser is to be balanced, according to the concepts of the Maxwellians, by the "angular momentum of the electromagnetic field". Here one has immediately to add that radiated electromagnetic energy has momentum density but it is an idiotism to speak about angular momentum density even for radiated electromagnetic energy, as angular momentum can have only masses rotating about an axis but radiated energy propagates linearly and cannot rotate about an axis.

Secondly the field momentum must be not "deposited", it must be radiated in a direction opposite to the direction of the condenser's rotation and immediately after being radiated it must begin to rotate about the axis of the apparatus, so that the total angular momentum of this radiated energy for any time interval must equalize the angular momentum acquired by the rotating mechanical system during this time interval (if there is no mechanical friction in the bearings of the rotating system and the time of acceleration of the condenser tends to infinity, also the angular momentum of the rotating system will increase to infinity).

We see that the concepts of the Maxwellians are so idiotic that normal man will never begin to explain why are they idiotic, as one of Murphy's laws states: Never argue with a fool, people might not know the difference.

Thus I shall not try to make a contribution in the revelation of the idiotism of the Maxwellians. I shall only show WHAT have G+L done and WHAT have they calculated, because:

1) their experiment is tremendously important, as this is the first experiment in human history where violation of the angular momentum conservation law has been observed,

2) they have calculated not this what they thought of having calculated.

I shall give a clear description of their experiment, as when reading their report the reader understands with difficulty what have they really done.

The essence of the G+L experiment is presented with my trick-track perpetuum mobile which I have proposed before having read the G+L article (see fig. 6 on p. 108 and p. 312 of TWT-II), althouh I have seen the G+L article in the year of its publication but, after perusing it, I could not grasp its essence.

The simplified explanation of the G+L experiment given by Pappas at the bottom of his p. 3 is right. I must add that to the condenser was applied an alternating tension $U = U_0\cos(2\pi\nu_1 t)$ producing an alternating current $I = I_0\cos(2\pi\nu_1 t)$, where ν_1 is the frequency, U_0 and I_0 are the amplitudes of tension and current and the phase between them is taken equal to zero, while on the coil was applied another alternating tension producing an alternating magnetic intensity $B = B_0\cos(2\pi\nu_2 t)$, where ν_2 is the frequency, and it was $\nu_1 = 243.31$ Hz, $\nu_2 = 242.18$ Hz.

Thus the torque (the moment of force) acting on the condenser was a periodic function of time and according to the Lorentz equation we have

$$M = \left|\int_b^a (1/c)\mathbf{r}\times(I d\mathbf{r}\times\mathbf{B})\right| = \int_b^a (r/c) I_0\cos(2\pi\nu_1 t) B_0\cos(2\pi\nu_2 t)dr =$$

$$(1/4c) I_0 B_0 (a^2 - b^2)\left[\cos\{\pi(\nu_1+\nu_2)t\} + \cos\{\pi(\nu_1-\nu_2)t\}\right], \qquad (12)$$

where a and b are the outer and inner radii of the cylindrical condenser.

<u>Disregarding</u> the high frequency component with period $2/(\nu_1+\nu_2)$, we can consider the torque acting on the condenser as simple periodic function with period $T = 2/(\nu_1 - \nu_2) = 1.770$ s, while the frequency of the tensions applied to the condenser and the coil can be taken equal to $\nu = (\nu_1 + \nu_2)/2 \cong 243$ Hz.

For the torque's amplitude we obtain, assuming $\nu_1 = \nu_2$,

$$M_0 = (1/2c) I_0 B_0 (a^2 - b^2). \qquad (13)$$

Denoting by q the quantity of electric charges on the condenser's plates and putting into (13)

$$I_0 = (\partial q/\partial t)_0 = C_0(\partial U/\partial t)_0 = 2\pi\nu C_0 U_0, \qquad (14)$$

we obtain

$$M_0 = (\pi/c)\nu C_0 U_0 B_0 (a^2 - b^2). \qquad (15)$$

In order to evade calculation difficulties, I shall consider the cylindrical condenser as a parallel plate condenser with distance between the plates $d = a - b$ and surface of the plates $S = \pi(a+b)h$, where h is the height of the cylindrical condenser, so that we shall write

$$C_0 = S/4\pi d = (a+b)h/4(a-b), \qquad (16)$$

and thus (15) can be written

$$M_0 = (\pi/4c)\nu U_0 B_0 h(a+b)^2. \qquad (17)$$

<u>According to the Maxwellians</u>, the same and oppositely directed torque must act on the displacement current in the condenser's gap. The <u>numerical</u> verification can be done straightforwardly, taking $U_0 = E_0(a - b)$ and $dV = \pi(a+b)hdr$,

$$M_0' = \left|\int_V (1/4\pi c)\mathbf{r}\times\{(\partial\mathbf{E}/\partial t)_0\times\mathbf{B}_0\}dV\right| = (1/4\pi c)\int_V r(2\pi\nu E_0)B_0\{\pi(a+b)hdr\} = (\pi/4c)\nu U_0 B_0 h(a+b)^2. \quad (18)$$

According to my concepts, the torque (12) - (15) does exist but the torque (18) does NOT exist. The torque (18) is a pure mathematical expression without any physical background.

Let us now see which is the amplitude of the torque acting on the radial conducting wires of the condenser.

I shall make the calculation according to formula (15). This formula is written in the CGS system of units; in the SI system of units it will have the form

$$M_o = \pi\nu C_o U_o B_o (a^2 - b^2) = \pi\nu C_o E_o B_o (a - b)^2 (a + b). \quad (19)$$

Putting here:

ν = 243 Hz,

C_o = 4.7 pF,

E_o = 1.3 MV m^{-1} (third row of the G+L table),

B_o = 0.22 T (third row of the G+L table),

a = 5.5 mm,

b = 4.5 mm,

we obtain

$$M_o = 10.3 \text{ pN m}. \quad (20)$$

As G+L write, "knowledge of the resonant amplitude and frequency, moment of inertia and free decay time" yielded a driving torque (third row of G+L table)

$$M_{o,obs} = 8.5 \text{ pN m}. \quad (21)$$

G+L have calculated a torque $(M_o)_{G+L}$ = 7.1 pN m. Their value is lower than my calculated value, as G+L write:

> I has been corrected for the known stray capacitance to earth external to suspension (~1 pF) and for the fraction of conduction current which corresponds to polarization current in the dielectric end plates, as that part corresponds to a closed loop of current contributing no torque.

The second correction done by G+L was WRONG. I showed that the polarization current (i.e., the displacement current in dielectrics), exactly for the same reasons as displacement current in vacuum, is NO CURRENT, as it neither generates magnetic field (I demonstrated this with my potential displacement current experiment - see TWT-I, p. 312) nor it reacts with kinetic forces to external magnetic fields (I demonstrated this with my Bul-Cub machine without stator - see TWT-III, p. 48, and with my Rotating Ampere Bridge with Displacement Current - see TWT-IV, p. 126). (See also p. 26 in this book.)

G+L write that their "calculated torque is exactly equal" to the right part of equation (8). I have shown above that the calculated torque is exactly equal numerically (but NOT physically) to the left part of equation (8) and it is easy to see that on the right side of equation (8) one has to take the time derivative not only of **E** but also of **B**, so that the right side of (8) is twice the left side of (8).

This is what G+L have done. They have OBSERVED that the current in a cylindrical coil can set in rotation a coaxial cylindrical condenser acting on its unequal radial current conducting wires. As the current in the condenser's wires cannot set the cylindrical coil in rotation (there is no possibility to set a cylidrical coil in rotation, as the magnetic forces are always perpendicular to the current elements), G+L have demonstrated for the first time in history (if not taking into account the machine of Robert Cook - see TWT-VI, p. 35) VIOLATION OF THE LAW OF ANGULAR MOMENTUM CONSERVATION.

All speculations of G+L about setting electromagnetic energy in rotation in order to save the angular momentum conservation law are PURE IDIOTISM.

Pappas' calculations on p. 4 of his article, although his intension is very good, and although the viewpoint defended by him is right, are somewhat confused. I should like to point out at these confusions.

First Pappas rewrites the wrong formula (9) of G+L for the "angular momentum of the electromagnetic field" (see Pappas' formula (6)). Then Pappas forgets to write **r** on the right side of his formula (6). Thus the correct Pappas' formula (6) must be, writing instead of Pappas' symbol **N** the symbol **M** and instead of Pappas symbol **H** the symbol **B**,

$$\mathbf{M} = \int_V \mathbf{r}\times\mathbf{F} = \int_V \mathbf{r}\times(d\mathbf{P}/dt) = \int_V \mathbf{r}\times d/dt(\mathbf{E}\times\mathbf{B}/4\pi c)dV. \tag{22}$$

Consequently Pappas' formula (7) is to be corrected to

$$\mathbf{P} = (1/4\pi c)\int_V \mathbf{E}\times\mathbf{B}\, dV, \tag{23}$$

and for **E** and **B** uniform and mutually perpendicular one obtains

$$P = EBV/4\pi c. \tag{24}$$

This formula is written in the system CGS; in the system SI it has the form

$$P = \varepsilon_0 EBV. \tag{25}$$

Putting here:

$\varepsilon_0 = 10^{-9}/36\pi\ C^2 kg^{-1} m^{-3} s^2$,

$E = 2.3\ MV\ m^{-1}$ (fifth row of G+L table),

$B = 0.22\ T$ (fifth row of G+L table),

$V = 471\ mm^3$ (according to Pappas' calculation, although the formula for the cylindrical condenser $C_0 = 2\pi\varepsilon_0 h/\ln(a/b)$, for Pappas value $C_0 = 5\ pF$, leads to $h = 18$ mm and not to $h = 15$ mm, as Pappas has calculated),

one obtains

$$P = 2.1\ pN\,s = 2.1\times10^{-12}\ N\,s. \tag{26}$$

Meanwhile Pappas has calculated $(P)_{Pappas} = 0.21\ fN\,s = 2.1\times10^{-16}\ N\,s$.

Let us stop here with the checking of Pappas calculations, as the reader might become bored.

Pappas writes:

A rigorous revision by the author of the major experimental evidence had shown that there is a serious (Pappas means "considerable" - S.M.) number of experiments that the Lorentz force law can not explain at all; and leads to erroneous conclusions, though the cardinal law is always straightforward applicable and in agreement with the observation. Such a case is the experiment by Graham and Lahoz, the Cemented Faraday Disk, etc.

I AFFIRM that Pappas has NOT calculated the force of interaction even of two most simple closed loops according to the Ampere formula. If he had tried to make such calculations (as I did in PROCEEDINGS OF ICSTA, p. 95), he would had seen that one comes to integrals which can be not taken in a final form.

To demonstrate that Pappas can calculate NOTHING with Ampere's formula, I pose to him the following problems. If he will be able to solve them, he will win a good money:

1. If Pappas will write the magnetic potential **A** generated by a current element Idr (Pappas can write the current element in his beloved form Ids) at a distance r along an arbitrary direction, so that by multiplying in a certain manner this magnetic potential **A** by another current element I'd**r**', he will obtain Ampere formula, I shall pay him \$ 1000. As, obviously Pappas will be unable to solve this problem, easily solvable for Grassmann's formula, the conclusion is to be drawn that Ampere's formula does not allow the introduction of the notion magnetic potential, and consequently also magnetic intensity.

2. If Pappas will obtain by calculation the torque acting on the currents along the radii of a cemented (or uncemented) Faraday disk, proceeding from Ampere's formula I shall pay him \$ 1000 (the coil must be taken as infinitely long with n turns on a meter).

3. I have calculated above (formula (13)) the torque acting on the current radii in the G+L experiment proceeding from Grassmann's (i.e., Lorentz') formula. If Pappas will be able to do the same by the help of Ampere's formula, I shall pay to him \$ 1000 (the current coil is to be taken as an infinite solenoid with n turns on a meter).

4. If Pappas will be able to calculate by the help of Ampere's formula the force of interaction between two current circular loops with radii R lying in the same plane with a distance r between their centers, I shall pay to Pappas \$ 100. This problem is solvable by approximate evaluation of the integrals, but as the computation is terrific, I shall gladly pay to Pappas the 100 dollars, if he will do the job. Let me note that the first problem is unsolvable, the second and the third are solvable, but even for 1000 dollars will Pappas not try to solve them. For solving problem 4) Pappas can use also computors.

The conclusion is the following: Nobody nowhere never has calculated the forces between current loops by the help of Ampere's formula, as this leads to tremendous mathematical DIFFICULTIES.

I end here with my analysis of the G+L experiments and of Pappas' criticism on this extremely important experiment.

I wonder that Pappas has not analysed in his paper my Bul-Cub machine without stator which is a modification of the G+L experiment and which patently shows a violation of the law of angular momentum conservation, as in this machine coil and condenser are solidly fixed one to another and both are freely suspended.

Pappas thinks that the opposite angular momentum is taken by the coil in the G+L experiment and he writes:

> I would like to make clear, without providing the necessary calculations, that the cardinal law provides the same numerical value for the observed torque without any kind of extra assumptions (Pappas will much more easily bite his own elbows than to provide the same numerical value by the help of Ampere's formula - S.M.), and the same time, it places the reaction force and reaction torque naturally on the causing the force agent, i.e., tangently on the coil. Unfortunately, G+L never considered this natural explanation provided by the cardinal law and they never searched for the reacting force on their coil.

Well, G+L have not searched for such a reaction force but I HAVE SEARCHED for it and I did not find such a reaction force in the coil. And Pappas KNOWS THIS very well but he evades to analyse my experiment in his paper. The answer of my Bul-Cub machine without stator is CATEGORICAL: There is no torque acting on the coil and thus Ampere's formula is wrong, as it predicts such a torque.

Further advantages of my Bul-Cub machine without stator with respect to the G+L experiment are the following:

1. In my experiment the magnetic field of the cylindrical magnet is concentrated only in iron and the whole magnetic flux crosses the condenser supplying a high magnetic intensity in the condeser's gap.

2. The gap of my cylindrical condenser is filled with dielectric with high permittivity, so that its capacitance is considerable. By inserting a big coil in series to the condenser, I balance the capacitance of the condenser by the inductivity of this coil which supplies the magnetic field setting the radial currents in the condenser's circuit into rotation. The current in the condenser's circuit of the G+L experiment, according to formula (14), where we put:

$\nu = 243$ Hz,

$C_0 = 4.7$ pF,

$U_0 = E_0(a - b)$, where $E_0 = 1.3$ MV m^{-1}, $a - b = 1$ mm,

was equal to

$$I_0 = 9.33\ \mu A, \tag{27}$$

while the current in my Bul-Cub machine was $I = 1.5$ A. The current "lever" of G+L was 1 mm, while mine was 20 mm.

3. Thus I set a body of about 2 kg in continuous rotation (G+L only oscillated the suspension) and my experiment becomes so impressive that only idiotized idiots can further sustain the opinion that the "opposite angular momentum" is "absorbed" by the "electromagnetic field".

4. In my Bul-Cub machine the predominant part of the displacement current is polarization current. If polarization current has the same magnetic properties as conduction

current, the Bul-Cub machine can be not set in rotation. Thus one has finally to throw over board the hundred years old lie that polarization current is current.

5. The Bul-Cub machine without stator generates electric current when it is set in rotation by an external torque. As there is no relative motion between "magnet" and "coil" in this experiment, it shows that the electromagnetic effects depend not on the relative velocities of the bodies (as the theory of relativity asserts) but on their absolute velocities (as my absolute space-time theory asserts).

I shall be very glad if Pappas will dedicate a critical analysis to my Bul-Cub machine without stator and with my above comments I show to him how he has to present his critical analysis.

However I do not believe that Pappas will dare to appear with such a critical opinion.

ARTE ECONOMIA FILOSOFIA LETTERATURA MUSICA POESIA POLITICA SCIENZA TEATRO

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SPECIALE ENERGIE ALTERNATIVE

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In un precedente articolo [1] ho presentato il mio *Ponte di Ampère Rotante.* Ora chiamerò questa macchinetta più precisamente *Ponte di Ampère Rotante. con Corrente di Spostamento* (PARCSp), in quanto la sua rotazione risultava dalla sostituzione della corrente di conduzione in alcuni fili del ponte (nei fili BC e FG - fig.1) con corrente di spostamento; questi fili, cioé, erano sostituiti con dei condensatori.

La macchinetta PARCSp violava la terza legge di Newton, tenendo conto che un corpo solido ruotava solo sotto l'azione delle forze interne. Ma essendo queste forze troppo deboli (i due condensatori con poca capacità non permettevano di raggiungere una forte intensità di corrente), non era possibile effettuare misure energetiche. Per misure energetiche intendo misure dell'energia elettrica che l'elettromotore consuma e dell'energia meccanica che esso fornisce. Secondo i concetti newtoniani e relativistici sulle forze interne, il PARCSp non dovrebbe consumare energia elettrica, cioé la potenza elettrica $P_{el} = IU$ da lui consumata durante il riposo e durante la rotazione dovrebbe essere la stessa, uguale alla potenza del calore liberata nei fili di rame del ponte $P_{cal} = I^2R$, dove U é la tensione fornita dalla sorgente, I é la corrente e R la resistenza ohmica del ponte.

Questa aspettativa dei relativisti é basata sul fatto che il PARCSp é un elettromotore dotato solo di rotore e senza statore. In questo motore i fili percorsi da corrente CD ed EF (fig.1) producono il campo magnetico che agisce sul filo percorso da corrente DE, mettendolo in moto. Ma essendo tutti questi fili attaccati solidamente l'uno all'altro, non c'é movimento relativo fra "magnete" (fili CD ed EF) e "bobina" (filo DE). Dunque nella "bobina", secondo i relativisti, la tensione elettrica, che in ogni motore convenzionale io chiamo tensione indotta opposta, non può apparire. Devo aggiungere che il termine "forza elettromotrice opposta" usato dalla fisica odierna é malscelto, e va abbandonato il più presto possibile.

Una delle ragioni sostanziali per cui gli studenti (e prima ancora i professori) capiscono molto male l'elettromagnetismo, é che i suoi termini non sono adatti, e i simboli neppure, così come non lo é il sistema di misura (SI), e soprattutto gli assiomi sono scelti impropriamente. Procedendo dalla mia assiomatica [2,3], l'elettromagnetismo diviene una teoria per bambini, e i suoi fondamenti possono essere appresi da qualsiasi persona normalmente dotata di intelligenza e che sappia un po' la matematica (calcolo differenziale, integrale e vettoriale), in cinque giorni (sei sono già troppi!).

Per verificare se sia possibile indurre la tensione opposta nel ponte di Ampére, nell'autunno del 1988 ho costruito il Ponte di Ampère con Contatti Striscianti (PARCSt), che é riprodotto in fig. 2 e in fig. 3 a destra. Qui la corrente elettrica può essere assai intensa, ed è possibile effettuare le misure energetiche.

Prima di presentare i miei risultati sperimentali, vorrei raccontare come va intesa la "trasformazione" dell'energia elettrica in energia meccanica in un elettromotore. Vorrei spiegare al lettore come sia una stupidaggine pensare che l'energia elettrica si "trasformi" in energia meccanica nello stesso modo in cui ognuno di noi trasforma una banana mangiata in cacca. Nei motori elettromagnetici c'è solo un'uguaglianza numerica fra l'energia meccanica che il rotore acquisisce e l'energia elettrica che la sorgente della tensione elettrica perde. Fino ad oggi l'uomo ha costruito elettromotori dove questa uguaglianza numerica è rigorosamente rispettata. Ma il mio motore con cuscinetti [4] e la macchina TESTATICA [1] hanno dimostrato che esistono motori dove questa uguaglianza numerica è violata.

Prendiamo dunque un motore convenzionale (pensate al motore che mette in moto il trenino di vostro figlio), assumendo che la sua resistenza ohmica sia $R = 10\Omega$. Se attacchiamo questo motore a una pila di $U = 20V$ e teniamo il suo rotore in riposo con la mano, la corrente sarebbe $I_{rip} = U/R = 2A$. La potenza che la pila perde sarà $(P_{el})_{rip} = I_{rip}U = 40W$. La potenza "trasformata" in calore dalla corrente che corre nei fili della bobina sarà $(P_{cal})_{rip} = I^2_{rip}R = 40W$ e avremo $(P_{el})_{rip} = (P_{cal})_{rip}$.

Se lasciamo libero il rotore, quest'ultimo assumerà un moto accelerato e nella sua bobina si indurrebbe una tensione opposta, aumentando fino ad un certo valore, diciamo U_{opp} = 10V, quando la velocità rotatoria non aumenta più. Per questo caso stazionario, siccome la tensione del circuito diventa U - U_{opp}, la corrente scenderà a I = (U - U_{opp})/R = 1A. Adesso la potenza consumata dalla pila sarà P_{el} = IU = 20W, mentre la potenza "trasformata" in calore sarà:

$P_{cal} = I(U - U_{opp}) = I^2R$ = 10W. La potenza $P_{mech} = P_{el} - P_{cal} = IU_{opp}$ = 10W sarà "trasformata" in energia meccanica del rotore, la quale, a sua volta, sarà "trasformata" in calore nei cuscinetti del rotore a causa dell'attrito. Se volete vedere P_{mech} come energia meccanica pura, pensate che non ci sia attrito e il vostro motore sia una pompa che alza in un secondo una certa quantità d'acqua di massa m ad una certa altitudine h. In tal caso avremo $(P_{mech})_{potenziale} = mgh$, dove g = 9.81 m/sec^2 è l'accelerazione gravitazionale. Lasciando cadere quest'acqua dall'altezza h, la sua energia cinetica acquistata $E = (P_{mech})_{cinetica} = mv^2/2 = m(2gh)/2 = mgh$ sarà esattamente uguale a $P_{mech} = IU_{opp}$.

La domanda che ci poniamo è: perchè in ogni motore che conosciamo il caso stazionario si verifica solo quando $IU_{opp} = mgh$? La risposta che la fisica odierna fornisce a questa domanda è: " Così esige la legge della conservazione dell'energia". E alla domanda "Chi ha scritto questa legge?" uno risponde "Javeh", l'altro "Maometto" ed un altro ancora "Newton" ("Mayer", "Osvald", ecc.) e tutti in coro concludono: "Questo è l'undicesimo comandamento divino. Punto e basta.".

Il motore con cuscinetti [1] non è un motore elettromagnetico ma un motore termico e dunque non si può parlare di tensione indotta opposta. La macchina TESTATICA [1] non mi è chiara. La macchina MAMIN COLIU [1] è un generatore senza effetto motore. Vediamo adesso se PARCSt è un motore senza effetto generatore (cioè senza tensione indotta opposta), visto che gli argomenti relativistici sono assai pesanti: PARCSp (PARCSt) è la seconda macchina al mondo , dopo la macchina BUL-CUB senza statore[1], che non ha lo statore, ma la BUL-CUB possiede l'effetto generatore.

La differenza tra PARCSp e PARCSt è la seguente: nel PARCSp i contatti "striscianti" sono nei punti B e G mentre nel PARCSt i contatti "striscianti" sono nei punti C e F (fig. 1). Nel PARCSt i fili BC e FG sono solidali al laboratorio e solo il ponte di Ampère CDEF si mette in moto (anche nel PARCSp il ponte CDEF si mette in moto, ma là i fili BC e FG non esistono). Come sia realizzata la costruzione per cui il moto propulsivo del ponte diviene moto rotativo lo si vede chiaramente nelle figure 2 e 3, in cui è mostrato come io abbia combinato il motore PARCSt (a destra) con un generatore che è stato inventato da Faraday nel 1830 e che si chiama disco di Faraday cementato (a sinistra). Il disco di Faraday rappresenta un magnete cilindrico (o anellare, come nel mio apparecchio) e un disco di metallo con contatti striscianti nel centro e alla periferia. Se il magnete è solidale al laboratorio e ruota soltanto il disco, si chiama disco di Faraday non cementato. Quando il disco di Faraday (cementato o non cementato) viene messo in moto da una forza esterna (diciamo dalla vostra mano come nella fig. 4), attraverso il suo raggio si induce una tensione

$$U_F = \left(\frac{1}{2}\right)\Omega\left(R^2_{est} - R^2_{int}\right)B, \qquad (1)$$

dove Ω è la velocità angolare e R_{est}, R_{int} sono i raggi esterno e interno del magnete anellare che produce l'intensità magnetica B nel disco attaccato.

Questa formula si deduce facilmente dalla formula fondamentale per l'intensità elettrica indotta in un filo che si muove con velocità v in un campo magnetico il cui potenziale è A (l'intensità magnetica è B = rotA)

$$E = v \times \text{rot}A = v \times B, \qquad (2)$$

tenendo conto che v = Ω x r, dove r è la distanza orientata di un elemento del disco dal suo asse, e

$$U_F = \int_{R_{int}}^{R_{est}} E \cdot dr \qquad (3)$$

è la tensione indotta attraverso il raggio del disco.

Dunque se il disco di Faraday viene fatto ruotare da una forza esterna, questo lavora come generatore di energia elettrica. D'altra parte, se attraverso il suo raggio passa corrente elettrica, il disco ruota come motore. In questo secondo caso la tensione indotta [1] si chiama tensione indotta opposta (nel primo caso U_F si chiama semplicemente tensione indotta e, più precisamente, tensione indotta diretta).

Chiedete a 100 ingegneri se il disco di Faraday cementato può ruotare come motore o generare tensione: 99 risponderanno "no". Su 100 fisici, 95 risponderanno "no". Perchè? Perchè il disco di Faraday cementato è una cosa scomodissima per la teoria della relatività, che non sa come spiegarne gli effetti. E nessun autore di libri sull'elettromagnetismo del nostro secolo tratta del disco di Faraday cementato. Poiché solo l'1% degli ingegneri e il 5% dei fisici leggono libri del XIX secolo, eccovi la spiegazione dei risultati deplorevoli della vostra indagine. Devo aggiungere che tutti e 200 fra i fisici e gli ingegneri di cui sopra risponderanno "no" se gli si chiederà se PARCSp e PARCSt possono ruotare.

Nel mio apparecchio (fig. 2 e 3) il disco di Faraday cementato è composto da due magneti anulari di neodimio (dunque magneti con alta B) ed un disco inserito fra loro. Quando il disco ruota, la corrente indotta passa dalla vaschetta riempita con mercurio, in cui è immersa la periferia del disco, alla vaschetta riempita con mercurio in cui è immerso il disco sinistro del ponte di Ampère rotante; attraversa il ponte e uscendo dalla vaschetta in cui è immerso il disco destro del ponte, raggiunge la vaschetta nella quale è immerso il piccolo disco all'estremità destra dell'asse grosso dell'apparecchio. Attraversando questo asse, la corrente ritorna al centro del disco di Faraday. La siringa a destra (si vede solo nelle fig. 2 e 4) serve a chiudere e a distaccare il circuito elettrico. Tutte le parti della macchinetta sono fatte di rame e la sua lunghezza è di 26 cm.

Ho chiamato questo apparecchio la macchina R.A.F. (Rotating Ampère bridge motor with sliding contacts coupled with a cemented Faraday disk generator). Il disco di Faraday produce corrente elettrica, il ponte di Ampère rotante mette in moto la macchina.

Ogni bambino (anch'io, quando avevo una quindicina d'anni) cerca di accoppiare un elettromotore con un generatore e realizzare un moto perpetuo, non conoscendo l'undicesimo comandamento divino. La macchina R.A.F. rappresenta esattamente questo "sogno infantile". Ma siccome il PARCSt nella R.A.F. è un motore senza statore, la macchina risulta violare o l'undicesimo comandamento o i concetti relativistici.

Supponiamo di aver messo in rotazione la macchina R.A.F. con la mano: in un certo momento la corrente nel circuito è I. La forza che agisce sulle cariche elettriche q in un elemento dr del raggio del disco, che frena la rotazione (effetto di motore), è (secondo la formula fondamentale (2) che determina la forza su un'unità di carica nel campo B)

$$f_F = qE = qv \times B = Idr \times B, \qquad (4)$$

dove v è la velocità di queste cariche (nella corrente elettrica le cariche hanno una velocità uguale alla velocità della luce, secondo me [4]) e dunque abbiamo $qv = Idr$.

Il momento della forza che agisce su tutto il raggio del disco di Faraday sarà, tenendo conto che r, dr, B sono tutti perpendicolari tra loro,

$$M_F = \left| \int_{R_{int}}^{R_{est}} r \times f_F \right| = \int_{R_{int}}^{R_{est}} IBrdr = \frac{1}{2} I \left(R_{est}^2 - R_{int}^2 \right) B. \qquad (5)$$

Dunque M_F sarà un momento di forza frenante. Il momento di spinta sarà fornito dal ponte di Ampère. La forza che agisce su un elemento di corrente Idx del braccio DE del ponte di Ampère (fig. 1) provocata dalla corrente in una delle gambe CD o EF era già stata calcolata nel precedente articolo (v. formula (7) nel [1]).

Per la forza che agisce su tutto il braccio otteniamo, lavorando nel (scomodo!) sistema SI usato nel presente articolo (dunque sostituendo, nella formula (7) del precedente articolo [1], $1/c^2$ con $\mu_0/4\pi$, dove $\mu_0 = 4\pi \cdot 10^{-7}$ N/A² è la costante magnetica nel sistema SI)

$$f_A = \left(\frac{\mu_0}{2\pi}\right)\int_{a_0}^{a}\left(\frac{I^2 L dx}{x}\right)\left(x^2 + L^2\right)^{-\frac{1}{2}} \cong \left(\frac{\mu_0 I^2}{2\pi}\right)\int_{a_0}^{a}\frac{dx}{x} =$$

$$= \left(\frac{\mu_0 I^2}{2\pi}\right)\ln\left(\frac{a}{a_0}\right), \qquad (6)$$

dove L è la lunghezza delle gambe CD e EF (non dimenticate che di gambe ce ne sono due), a è la lunghezza del braccio DE ed a_0 è una lunghezza molto più piccola di a (aspettate e vedrete cos'è a_0). Per un ponte con $a/L < 0.33$ l'approssimazione nella (6) introduce un errore non maggiore di un 5%. Infatti abbiamo $1 > L\,(x^2 + L^2)^{-1/2} > L\,(a^2 + L^2)^{-1/2} = (0.33^2 + 1)^{-1/2} = 0.95$. Dunque l'espressione alla parte destra della (6) è abbastanza buona per calcolare la forza che agisce sul ponte di Ampère.
Con l'esperimento presentato nella fig. 5 del precedente articolo [1] ho stabilito che se nel ponte di Ampère la corrente è 1A, la forza propulsiva è $5 \cdot 10^{-6}$ N/A² con una approssimazione del 50%, dunque la forza è circa $(2.5 - 7.5) \cdot 10^{-6}$ N/A² e dipende da diversi fattori: lunghezza del braccio a, rapporto a/L, diametro del filo, forma della curvatura agli angoli. Dunque ho deciso di chiamare questo ponte di Ampère, in cui la forza propulsiva è esattamente $5 \cdot 10^{-6}$ N/A², un ponte di Ampère normale, e ho chiamato fattore-forza del ponte di Ampère normale il numero $\alpha = 5 \cdot 10^{-6}$ N/A². Essendo $\mu_0 = 4\pi \cdot 10^{-7} = 1.26 \cdot 10^{-6}$ N/A², si deduce che il numero μ_0 è molto vicino al fattore-forza del ponte di Ampère normale. Per ogni ponte di Ampère concreto introduco un fattore G che chiamo fattore geometrico, cosicchè αG è la forza propulsiva di ogni ponte di Ampère concreto quando la corrente è di 1A. Per una corrente I la forza propulsiva del ponte sarà $f_A = I^2 \alpha G$. Dunque il momento del ponte di Ampère rotante relativamente al suo asse sarà (v. fig. 1-3)

$$M_A = R_A f_A = R_A I^2 \alpha G, \qquad (7)$$

dove R_A è il raggio BC = FG.

Se adesso prendiamo in considerazione la formula (6) possiamo scrivere

$$\alpha G = \left(\frac{\mu_0}{2\pi}\right)\ln\left(\frac{a}{a_0}\right) \qquad (8)$$

e troviamo che per un ponte di Ampère normale è $\ln(a/a_0) = 25$. Da qui stabiliamo la piccola distanza $a_0 = e^{-25}a = 1.4 \cdot 10^{-11}$ a. Prendendo nella formula (6) $a_0 = 0$, come la geometria esige per un filo di sezione prossima allo zero, arriviamo ad una forza f_A infinita. Questa "singolarità" (come dicono i matematici) nella fisica non può esistere, e vediamo che a_0 rimane una quantità molto piccola (10^{-11} a) ma comunque diversa da zero.

Devo aggiungere che nella teoria qui presentata ho supposto che sul ponte di Ampère agiscano solo forze magnetiche. Forse c'è anche un effetto (certamente più piccolo) causato dal *current jet effect* considerato in [4] (p. 99).

Prendiamo anche in considerazione il fatto che la formula (7) è valida per un ponte. Se ci sono n ponti paralleli (nelle fig. 2 e 3 è n = 4), il fattore geometrico diventa $G_n = G/n$, tenendo conto che l'effetto è proporzionale a I^2, e dunque su n ponti paralleli agisce una forza n volte più debole di quella che, per la stessa corrente, agisce su un solo ponte.

La potenza meccanica che il ponte di Ampère rotante produce è $P_{mech} = M_A\Omega$. Secondo l'undicesimo comandamento divino deve essere indotta nel ponte una tensione opposta U_A tale che l'equazione

$$P_{mech} \equiv M_A\Omega = IU_A \equiv P_{el} \qquad (9)$$

sia soddisfatta (v. l'inizio dell'articolo). Mettendo qui (7), otteniamo per la tensione opposta generata nel ponte

$$U_A = R_A\, I\alpha G\Omega. \qquad (10)$$

Se il senso della rotazione è tale che il momento della forza del ponte di Ampère sopporta la rotazione, abbiamo una rotazione sopportata. In questo caso M_A è contrario a M_F e U_A è contrario a U_F. Se il senso della rotazione è tale che il momento della forza del ponte di Ampère frena la rotazione, abbiamo una rotazione frenata. In questo caso M_A ha lo stesso senso di M_F e U_A ha la stessa direzione di U_F.

Vediamo cosa ha mostrato l'esperimento. Prima ho smontato i magneti del disco di Faraday e ho stabilito come ruota il ponte applicando la tensione di una batteria con fili assai grossi, attaccandoli alle due viti della macchina. La corrente veniva misurata mediante un amperometro non contattabile attaccato ad uno di questi fili. La tensione sul ponte veniva misurata mediante un voltmetro inserito nei due fori che si vedono sulla parte frontale della macchina. Con una corrente I = 1200 A la macchina ruotava con 5g/sec. La tensione sul ponte era 30 mV e quindi la resistenza del ponte era 25μΩ, un valore che è abbastanza prossimo a quello calcolato dalla geometria del ponte, tenendo conto che la resistenza di un filo di rame lungo 1m con sezione di $1mm^2$ è di 15.5mΩ (il lettore può fare il calcolo solo se la TV lo annoia).

Misurando nello stesso modo la resistenza di tutto il circuito ho trovato R = 40μΩ. Ho fatto due serie di misure: nella prima serie il ponte di Ampère non era solidale all'asse dell'apparecchio e lo tenevo in riposo avendo smontato i due anelli plastici con i quali il ponte è attaccato all'asse. Nella seconda serie il ponte di Ampère era attaccato all'asse come nelle fig .2 e 3. L'asse di un elettromotore esterno era collegato mediante attrito al magnete sinistro del disco di Faraday e metteva in rotazione la macchina con velocità costante. I risultati delle misure sono presentati nella tavola seguente:

Velocità rotativa $\Omega/2\pi$ g/sec	Tensione indotta nel disco di Faraday: U_F mV		Tensione sul ponte misurata per circuito chiuso: ΔU mV				Tensione indotta nel ponte: U_A mV calcolata secondo formula (10)
			Ponte distaccato dall'asse		Ponte attacato all'asse		
	calcolata secondo formula (1)	misurata per circuito aperto	senso dir.	senso opp.	rot. sopp.	rot. fren.	
1	2.8	2.8	1.7	1.7	1.7	1.7	0.016
2	5.7	5.7	3.6	3.6	3.6	3.7	0.067
3	8.5	8.5	5.3	5.3	5.2	5.4	0.150
4	11.3	11.4	7.1	7.1	6.9	7.2	0.268
5	14.1	14.2	8.8	8.9	8.7	9.2	0.418
6	17.0	17.1	10.7	10.7	10.3	11.0	0.604
7	19.8	20.0	12.4	12.5	12.0	13.0	0.824

La tensione U_F indotta nel disco di Faraday è calcolata secondo la formula (1) tenendo conto che: l'intensità magnetica misurata con una sonda di Hall ad una distanza fra i magneti anellari di 4mm (uguale allo spessore del disco di rame) era B = 0.35 T, il raggio esterno del magnete era R_{est} = 6cm, il raggio interno del magnete era R_{int} = 3.2cm.

La tensione U_A che deve essere indotta nel ponte di Ampère secondo l'undicesimo comandamento divino è calcolata secondo la formula (10) tenendo conto che: la leva del ponte di Ampère era R_A = 3cm, come fattore geometrico del ponte di Ampère era stato scelto $G_{n=4} = 1/4$, dunque ho supposto che i miei ponti di Ampère fossero ponti normali; la corrente I è calcolata mediante la formula $I = U_F/R$ con $R = 40\mu\Omega$, che è quasi uguale alla corrente ottenuta dalla tensione ΔU misurata sul ponte distaccato e la sua resistenza ohmica $R_{ponte} = 25\,\mu\Omega$.

Le colonne 6, 7 e 8 mostrano chiaramente quale sia la tensione indotta nel ponte di Ampère rotante, siccome le tensioni sul ponte, per rotazione sopportata e frenata, sono esattamente:

$\Delta U_{sopp} = (U_F - U_A)\,R_{ponte}/R$ e $\Delta U_{fren} = (U_F + U_A)R_{ponte}/R$.

Questo effetto non può essere spiegato dalla teoria della Relatività perchè qui l'effetto di induzione non dipende dalla velocità di un magnete (filo percorso da corrente) nei riguardi di un filo, ma dalla velocità comune del "magnete" e del "filo" che sono solidamente attaccati l'uno all'altro.

Se la tensione opposta non fosse indotta, la macchina R.A.F. genererebbe un moto perpetuo.

Ecco perchè:

Con la mia macchina R.A.F. ho fatto le seguenti misure energetiche. Dopo aver impresso alla macchina una velocità di 7g/sec, distaccavo l'elettromotore esterno e lasciavo arrivare la macchina a riposo misurando il tempo.

1) *Misure con il ponte di Ampère distaccato dall'asse:*

a) Per circuito aperto: T_{1a} = 56 sec.

b) Per circuito chiuso e senso di rotazione diretto: T_{1b} = 35 sec.

c) Per circuito chiuso e senso di rotazione inverso: T_{1c} = 35 sec.

2) *Misure con il ponte di Ampère collegato all'asse:*

a) Per circuito aperto: T_{2a} = 65 sec.

b) Per circuito chiuso e rotazione sopportata: T_{2b} = 47 sec.

c) Per circuito chiuso e rotazione frenata: T_{2c} = 43 sec.

Se J è il momento inerziale del mio rotore, allora tutta l'energia che venga introdotta nella macchina, mettendola in rotazione con velocità angolare Ω, è l'energia cinetica del rotore: $E_{cin} = (1/2)J\Omega^2$.

Nei casi 1a e 2a non si verifica passaggio di corrente, e tutta l'energia E_{cin} si trasforma in calore a causa dell'attrito nei cuscinetti e nelle vaschette con mercurio. Ed essendo $J_1 < J_2$, il tempo T_{1a} è minore del tempo T_{2a}.

Nei casi 1b e 1c c'è corrente indotta, il disco di Faraday frena e l'energia

$$(E_F)_{cal} = \int_0^T \left(\frac{U_F^2}{R}\right) dt \qquad (11)$$

si trasforma in calore.

Nei casi 2b e 2c l'energia che deve trasformarsi in calore è

$$(E_{F+A})_{cal} = \int_0^T \left\{\frac{(U_F \mp U_A)^2}{R}\right\} dt, \qquad (12)$$

dove il segno "-" è per il caso 2b e il segno "+" è per il caso 2c. I tempi T_{2b} = 47 sec e T_{2c} = 43 sec corrispondono a questi due casi, visto che nel caso 2b la potenza termica è più bassa che nel caso 2c.

Se invece avessimo $U_A = 0$, allora la tensione nella macchina sarebbe U_F, mentre il momento frenante sarebbe $M_{RAF} = M_F \mp M_A$, dove il segno "-" sta per rotazione sopportata e il segno "+" per rotazione frenata. Dunque se si potesse avere anche $M_A > M_F$ la macchina comincerebbe a muoversi da sola con moto accelerato. Nella mia macchina RAF, per 7g/sec si ha $U_F = 20$mV, e siccome $R = 40\mu\Omega$, la corrente per questa velocità risulterebbe essere I = 500A. Quindi, per questa corrente, secondo le formule (5) e (7) avremmo $M_F = 0.225$ Nm e $M_A = 0.009$ Nm. Si vede così che M_A è più di 20 volte inferiore a M_F. Ma se facessimo $R = 0.4\ \mu\Omega$, otterremmo I = 50kA, e avremmo allora $M_F = 22.5$ Nm e $M_A = 90$ Nm.

Ci sarebbero anche modi più semplici per far girare in eterno la macchina RAF, se U_A non esistesse: ricavando, nella condizione per la rotazione eterna $M_A = M_F$, il momento M_F dalla formula (5) e il momento M_A dalla formula (7) e ponendo $I = U_F/R$, dove ricaviamo dalla formula (1) la tensione U_F generata nel disco di Faraday. Si giunge così al risultato $R_A = R/\Omega\alpha G$. Ponendo qui $R = 40\mu\Omega$, $\Omega = 14\pi\ sec^{-1}$, $\alpha = 5 \cdot 10^{-6}\ N/A^2$, $G = 1/2$ (dunque facendo la macchina con due ponti di Ampère normali), otteniamo $R_A = 0.36$ m. Si vede dunque che se $U_A = 0$, la costruzione di una macchina RAF che si muova eternamente diverrebbe un gioco da ragazzi: si devono prendere due ruote da bicicletta, cambiare i pneumatici con degli anelli di rame aventi le periferie immerse nelle due vaschette contenenti mercurio, montare su di loro due ponti di Ampère paralleli e collegare loro un disco di Faraday cementato. Ma *per sfortuna* i concetti relativistici non sono veri, e nel PARCSt compare una tensione indotta opposta.

Il mio amico Prof. Pappas ha compiuto, in Atene, un simile esperimento, dove però il "magnete" è in riposo e solo il "filo" si muove. In questo esperimento c'è tensione indotta opposta, e questo effetto è spiegato dalla teoria della relatività. Presenterò qui l'esperimento di Pappas [5 - p.169], purchè il lettore possa notarne le differenze, poi presenterò le mie spiegazioni dell'effetto nel ponte di Ampère, abbassando così i calzoni ai relativisti.

Nell'esperimento di Pappas [5] (fig.5) due dischi di rame possono essere ruotati su un asse da un motore esterno. Le periferie dei dischi sono immerse nelle due vaschette contenenti mercurio. La corrente procede dal lettore verso la vaschetta sinistra, percorre il disco di sinistra, l'asse, il disco di destra e torna verso il lettore, dove si trova la sorgente. Le dimensioni sono in millimetri.

Il primo effetto osservato da Pappas era la rotazione dei due dischi quando era fatta passare una corrente di un centinaio di Ampère. Infatti la macchina di Pappas presenta due semi-ponti di Ampère collegati l'uno all'altro. Io chiamo un tale semi-ponte disco di Ampère-Faraday, perchè esso è effettivamente una "simbiosi" del ponte di Ampère e del disco di Faraday.

Il secondo effetto più importante per noi, adesso, che Pappas ha osservato è l'induzione di tensione nel disco durante la sua rotazione al passaggio di una certa corrente I. Le tensioni misurate sui due dischi di Ampère-Faraday sono elencate nella fig .6. I valori alti sono per rotazione frenata, quelli bassi per rotazione sopportata; quelli medi sono per il caso in cui i dischi non ruotano.

Per verificare se la mia teoria corrisponde alle osservazioni di Pappas procediamo dalla formula (6) del precedente articolo [1] per il potenziale magnetico A generato dal filo con lunghezza L che conduce la corrente (chiamiamolo "gamba") ad una distanza x sul raggio del disco (chiamiamolo "semi-braccio") dal contatto strisciante nella vaschetta contenente mercurio. Se prendiamo un sistema di coordinate cartesiane con origine nel contatto strisciante, con asse x lungo il semi-braccio, con asse y lungo la continuazione della gamba e assumiamo come direzione della corrente quella dal contatto strisciante al centro del disco, la formula (6) del precedente articolo [1] scritta nel sistema SI risulterebbe essere:

$$A = \left(\frac{\mu_0}{4\pi}\right) I \ \mathrm{Arsinh}\left(\frac{L}{x}\right)\hat{y}. \qquad (13)$$

Per il disco di Ampère-Faraday il "magnete" (la gamba percorsa da corrente) è solidale al laboratorio (dunque presenta uno "statore") e la "bobina" (il semi-braccio) si muove (dunque presenta un "rotore"). Dunque lungo il raggio a del disco sarà indotta una tensione opposta. Se la velocità angolare del disco è $-\Omega\hat{z}$, l'intensità elettrica indotta lungo il raggio del disco è, secondo la formula (2):

$$E = (a - x)\,\Omega\hat{y} \times \mathrm{rot}\,A = -\left(\frac{\mu_0 I}{4\pi}\right)\left(\frac{a}{x} - 1\right)\Omega L \left(L^2 + x^2\right)^{-\frac{1}{2}}\hat{x} \cong$$

$$\cong -\left(\frac{\mu_0 I}{4\pi}\right)\left(\frac{a}{x} - 1\right)\Omega\hat{x} \qquad (14)$$

e per $a/L < 0.33$ l'approssimazione introduce un errore non superiore al 5% (v. sopra).

Per la tensione indotta nei due dischi otteniamo:

$$U_{A-F} = 2\int_{a_0}^{a}\left(\frac{\mu_0 I\Omega}{4\pi}\right)\left(\frac{a}{x} - 1\right)dx = \left(\frac{\mu_0 I\Omega}{2\pi}\right)a\left\{\ln\left(\frac{a}{a_0}\right) - 1\right\}. \qquad (15)$$

Siccome a_0 è una quantità molto più piccola di a, non importa se nell'espressione $\ln(a/a_0)$ a sia il braccio o il semi-braccio del ponte di Ampère, e per un semi-ponte normale (dunque per un semi-ponte sul quale la forza è $2.5 \cdot 10^{-6}\ N/A^2$) dobbiamo prendere $\ln(a/a_0) = 25$. Perciò otteniamo:

$$U_{A-F} = \left(\frac{12}{\pi}\right)\mu_0 I\Omega\, a. \qquad (16)$$

Se poniamo qui $I = 63A$, $\Omega/2\pi = 6.9\ g/sec$, $a = 0.2\ m$ (le cifre sono prese dalle figure 5 e 6) troviamo $U_{A-F} = 2.6$ mV. Il grafico di Pappas (fig . 6) mostra che per I = 63 A lui ha ricavato $U_{A-F} = 2.7$ mV per rotazione sopportata e $U_{A-F} = 2.0$ mV per rotazione frenata. Dunque se i due semi-ponti di Ampère costruiti da Pappas vengono considerati come un ponte normale, la teoria coincide con le osservazioni fatte.

Devo notare qui che io ho dedotto la formula (10) per la tensione opposta nel ponte di Ampère procedendo dalla legge di conservazione dell'energia, mentre ho dedotto la formula (15) per la tensione opposta nel disco di Ampère-Faraday procedendo dalle formule dell'elettromagnetismo. Si vede facilmente che le due vie portano a risultati uguali. Infatti, ponendo (8) in (10) si ottiene:

$$U_A = \left(\frac{\mu_0}{2\pi}\right)R_A I\Omega \ln\left(\frac{a}{a_0}\right) \qquad (17)$$

e questa formula va paragonata con la formula (15), notando che i due casi non sono completamente uguali: la leva R_A nel ponte di Ampère è la stessa per ogni elemento del braccio, mentre la leva nel disco di Ampère-Faraday è diversa per i diversi elementi del semi-braccio.

Adesso affrontiamo il grande problema: come possiamo scrivere una equazione simile alla (14) per il ponte di Ampère quando i fili percorsi da corrente che generano il potenziale magnetico A (i fili BD e EF nella fig. 1) nel ponte di Ampère si muovono con la stessa velocità del filo nel quale l'intensità E dovrebbe essere indotta (il filo DE nella fig.1)? I relativisti, poverini, questo problema non lo possono risolvere. I relativisti debbono: o ammettere che nel ponte di Ampère non può essere indotta una tensione opposta (e conseguentemente contraddire l'undicesimo comandamento), o ammettere che non sono le velocità relative dei corpi che determinano gli effetti fisici nel nostro mondo bensì le loro velocità assolute, e dunque debbono pisciare sul principio della relatività.

La soluzione di questo problema è facile (ho già detto che l'elettromagnetismo è una "zuppa di fagioli"), ma se l'umanità non l'ha capita durante quasi due secoli e da parecchi anni dopo che io ho annunciato la scoperta dell'induzione mozionale-trasformatoria rifiuta di accettarla, bisogna leggere le pagine seguenti con attenzione.

Sarebbe interessante aggiungere che siccome nessun giornale di fisica dell'*establishment* ha acconsentito la pubblicazione della scoperta dell'induzione mozionale-trasformatoria, ho dovuto farlo con due *advertisements* pagando 1000 sterline a NATURE e 4000 a NEW SCIENTIST (che vergogna!). Se non verrà chiarito il problema dell'induzione nel ponte di Ampère così profondamente come segue, il lettore rimarrà sommerso dai dubbi: "Nel ponte di Ampère c'è o non c'è tensione opposta indotta? ". Aspettiamo che i leoni aprano la bocca. Fino a quel momento non diremo né sì né no poiché è più facile.

Nel Vangelo invece sta scritto (Matteo - 33: 33): "Beati quelli che con i propri occhi vedono lo splendore divino e non aspettano la benedizione del Papa, perchè loro andranno nel regno celeste.". (Matteo - 33: 34) : "Il Santo Padre, come ogni peccatore sulla terra, spesso sbaglia.".

E ancora una nota: ho inviato il mio rapporto sul ponte di Ampère rotante ad alcuni giornali scientifici. Mi hanno risposto: "E' una macchina che non può ruotare" [5]. Ho scritto ai redattori: "*Gentlemen* onorabili, la rotazione può essere verificata anche dai bambini. Prendete il ponte che si vede nella fig. 9 del precedente articolo[1] (che ogni bambino tedesco treenne può costruire in due ~ tre ore) e mettetelo sui binari presi da un trenino giocattolo, e con una decina di Ampère il ponte comincerà a ruotare su di essi.". I *gentlemen* onorabili dei giornali scientifici, con le teste grandi come sincrotroni, si sono sentiti offesi dal fatto che voglio far saltare i fondamenti della fisica odierna con i giocattoli e non mi hanno nemmeno risposto.

La forza che agisce su un'unità di carica elettrica nel campo del potenziale elettrico Φ e del potenziale magnetico A generati da un sistema di cariche elettriche, che io chiamo **intensità elettrica globale** (*global intensity*), è:

$$E_g = - \text{grad}\Phi - \frac{\delta A}{\delta t} + v \times \text{rot}\, A . \qquad (18)$$

Questa è la cosiddetta **equazione di Lorentz** (che io chiamo **equazione di Newton-Lorentz** [2,3]). E' l'equazione fondamentale dell'elettromagnetismo, e si deduce [2,3] facilmente[*] dalle formule per l'energia elettrica e per l'energia magnetica di due cariche elettriche q_1 e q_2 che si muovono con velocità, rispettivamente, v_1 e v_2, ad una distanza r l'una dall'altra, procedendo dalla legge della conservazione dell'energia:

$$U = \frac{q_1 q_2}{4\pi\varepsilon_0 r}, \quad W = \frac{\mu_0 q_1 q_2 v_1 \cdot v_2}{4\pi r}, \qquad (19)$$

[*] Nella mia teoria tutto può essere fatto facilmente, perchè il dodicesimo comandamento divino dice: "Ogni teoria complicata è sbagliata".

dove ε_0 e μ_0 sono le costanti elettrica e magnetica del vuoto (le formule sono scritte nel sistema SI).

$$E \equiv E_{rest} = -\operatorname{grad}\Phi - \frac{\delta A}{\delta t} \quad (20)$$

si chiama intensità elettrica, e più precisamente intensità elettrica di riposo (*rest intensity*).

$$E_{mot} = v \times \operatorname{rot}A \quad (21)$$

si chiama intensità elettrica mozionale (*motional intensity*) - v. formula (2).

$$E_{coul} = -\operatorname{grad}\Phi \quad (22)$$

si chiama intensità elettrica di Coulomb (*Coulomb intensity*), e siccome in questo articolo si è assunto $\Phi = 0$, la si può trascurare.

$$E_{tr} = -\frac{\delta A}{\delta t} \quad (23)$$

si chiama intensità elettrica trasformatoria (*transformer intensity*). Questa presenta due aspetti nel caso in cui il potenziale magnetico A sia generato da corrente che corre nei fili di metallo:

a) Nel caso in cui i fili rimangano a riposo e solo la corrente vari, la chiamo intensità elettrica trasformatoria di riposo (*rest-transformer intensity*)

$$E_{rest-tr} = -\frac{\delta A(t)}{\delta t} \quad (24)$$

e in questo caso A è una funzione diretta del tempo t.

b) Nel caso in cui la corrente nei fili rimanga costante ma i fili si muovano, la chiamo intensità elettrica mozionale-trasformatoria (*motional-transformer intensity*)

$$E_{mot-tr} = -\sum_{i=1}^{n} \frac{\delta A_i\,\{r_i\,(t)\}}{\delta t} =$$

$$= \sum \left(\frac{\delta A_i}{\delta x_i}\frac{\delta x_i}{\delta t} + \frac{\delta A_i}{\delta y_i}\frac{\delta y_i}{\delta t} + \frac{\delta A_i}{\delta z_i}\frac{\delta z_i}{\delta t} \right) =$$

$$= \sum (v_i \cdot \operatorname{grad})\, A_i\,, \quad (25)$$

dove $v_i = -\partial r_i / \partial t_i$ è la velocità del "i-esimo" elemento di corrente dei fili, cosicchè $-v_i$ è la velocità della carica unitaria di riferimento nel sistema inerziale movente, nel quale l'elemento di corrente è a riposo, e in questo caso A è una funzione composita del tempo tramite le distanze degli elementi di corrente dalla carica di riferimento.

Dunque se abbiamo un magnete (con corrente costante nei suoi fili), che genera in un certo punto di riferimento il potenziale magnetico A, e un filo in questo punto, possiamo avere i due casi seguenti:

a) Il magnete è a riposo, il filo si muove con velocità v: nel filo sarà indotta l'intensità elettrica mozionale secondo la formula (21).

b) Il filo è a riposo, tutto il magnete si muove con velocità v: nel filo sarà indotta l'intensità elettrica mozionale-trasformatoria (v. formula (25)).

$$E_{mot-tr} = (v \cdot \operatorname{grad})\, A\,. \quad (26)$$

La fisica di oggi invece, procedendo dal principio della relatività, dice che nel secondo caso l'intensità indotta sarebbe:

$$E = - v \times \mathrm{rot} A \qquad (27)$$

Questa è una formula sbagliata, ma da un secolo la gente non vuole capire che la formula giusta è la (26). La scoperta dell'induzione mozionale-trasformatoria è una delle più importanti scoperte del XX secolo. Infatti ogni bambino che conosca un po' la matematica dovrebbe arrivare dalla formula (18) alla formula (26), e mai alla (27). Sì! Ogni bambino dovrebbe arrivare alla formula (26), ma i relativisti-rinoceronti arrivano alla formula (27) perchè davanti a se non vedono niente altro che i baffi del maestro.

Vediamo adesso che succederebbe se magnete e filo si muovessero insieme con velocità v nello spazio assoluto (per i relativisti le parole "spazio assoluto" sono più terrificanti che per il diavolo il nome di Gesù). I relativisti più stupidi dicono che lo spazio assoluto non esiste, e che se un sistema chiuso si muove con velocità costante o meno, tutti gli effetti nel sistema rimangono gli stessi, e che questo principio lo aveva stabilito Galileo guardando come volano le mosche nella cabina di un piroscafo. I relativisti più intelligenti dicono che anche se questo spazio assoluto esistesse (la sua esistenza è stata confermata dal Prof. Bondi il 23 maggio 1988 a Bologna, durante la conferenza *"Cosmology in retrospection"*), siccome le intensità (21) e (27) sono uguali e opposte, l'intensità risultante sarebbe zero.

Ma non è così! L'intensità risultante sarà:

$$E_{res} = E_{mot} + E_{mot-tr} = v \times \mathrm{rot} A + (v \cdot \mathrm{grad}) A \qquad (28)$$

e nel caso in cui E_{mot} non sia uguale e opposta a E_{mot-tr}, l'intensità risultante non sarà zero.

Ho stabilito questo con il mio quasi-Kennard experiment [5-p.110], che è quasi un ponte di Ampère, con il quale ho misurato la velocità assoluta della terra. E' un esperimento facilissimo non solo come teoria, ma anche come esecuzione, ma i rinoceronti corrono nella scia del loro maestro e fanno come se questo esperimento non esistesse.

Anche l'induzione misurata da me nel ponte di Ampère rotante nella macchina RAF conferma la formula (28).

Calcoliamo infatti le induzioni mozionale e mozionale-trasformatoria che la corrente nella gamba del ponte induce nel braccio. Procedendo dal potenziale magnetico (13) e prendendo $\mathbf{v} = v\hat{y}$, si ottiene, secondo la formula (21):

$$E_{mot} = v \times \mathrm{rot} A = - \left(\frac{\mu_0 vI}{4\pi}\right) \hat{y} \times \left\{ \hat{y} \times \mathrm{grad}\left[\mathrm{Arsinh}(L/x)\right]\right\} =$$

$$= \left(\frac{\mu_0 vI}{4\pi}\right) \hat{y} \times \hat{z} \left[\frac{\delta\, \mathrm{Arsinh}\,(L/x)}{\delta x}\right] =$$

$$- \left(\frac{\mu_0 vIL}{4\pi x}\right) \left(x^2 + L^2\right)^{-\frac{1}{2}} \hat{x} \cong - \left(\frac{\mu_0 vI}{4\pi x}\right) \hat{x}, \qquad (29)$$

mentre secondo la formula (26) abbiamo:

$$E_{mot-tr} = (v \cdot \mathrm{grad}) A = \left(\frac{\mu_0 vI}{4\pi}\right) \left[\frac{\delta\, \mathrm{Arsinh}\,(L/x)}{\delta y}\right] \hat{y} = 0. \qquad (30)$$

Dunque secondo la formula (28) l'intensità risultante indotta sarà la stessa che nella formula (29), e la tensione indotta opposta lungo tutto il braccio sotto l'azione delle correnti nelle due gambe sarà quella della formula (17).

Ecco tutta la filosofia sull'induzione di tensione opposta nel ponte di Ampère!

Il lettore certamente esclamerà: "Ma è vero tutto questo? E allora perchè mai gli scienziati non hanno capito cose così semplici in quasi due secoli di elettromagnetismo e ancora oggi non sanno se il ponte di Ampère rotante possa ruotare o meno e, nel caso che ruoti, se ci sia tensione indotta opposta o meno? E se il ponte di Ampère volante[1] possa volare e se ci andremo sulla Luna con quel tappeto volante?"

E come mai? Ricordo questa storia di quando ero bambino.

Tornai un giorno a casa da scuola, e vidi che il nonno, la nonna, il papà, la mamma, i fratellini e le sorelline erano nel giardino, tutti molto agitati.

"Che c'è?" dissi io.

"Vieni, vieni anche tu. Il nonno ha perso gli occhiali nel giardino e li stiamo cercando già da un'ora!"

Senza dire una parola presi la scala e l'appoggiai al muro per salire sul tetto (la nostra casa era piuttosto bassa).

"Ma dove vai?!" gridarono tutti.

"Vado a vedere lassù", risposi. "Tutti state cercando nel giardino da un'ora: è chiaro che nel giardino non ci sono! Vado a vedere sul tetto. E se non sono nemmeno là, esiste soltanto una terza ed unica possibilità: che siano sul naso del nonno!".

Appena dissi ciò mio nonno esclamò:

"Che diavolino quel Stefanotto! Sono veramente sul mio naso!".

Bibliografia

[1] S.Marinov, *SEAGREEN* n.7, p. 34 (1988).

[2] S.Marinov, *Eppur si muove* (C.B.D.S., Bruxelles, 1977, terza edizione, East-West, Graz, 1987).

[3] S.Marinov, *Classical Physics* (East-West, Graz, 1981).

[4] S.Marinov, *The Thorny Way of Truth*, Part II (East-West, Graz, 1984, terza edizione 1986).

[5] S.Marinov, *The Thorny Way of Truth*, Part IV (East-West, Graz, 1989).

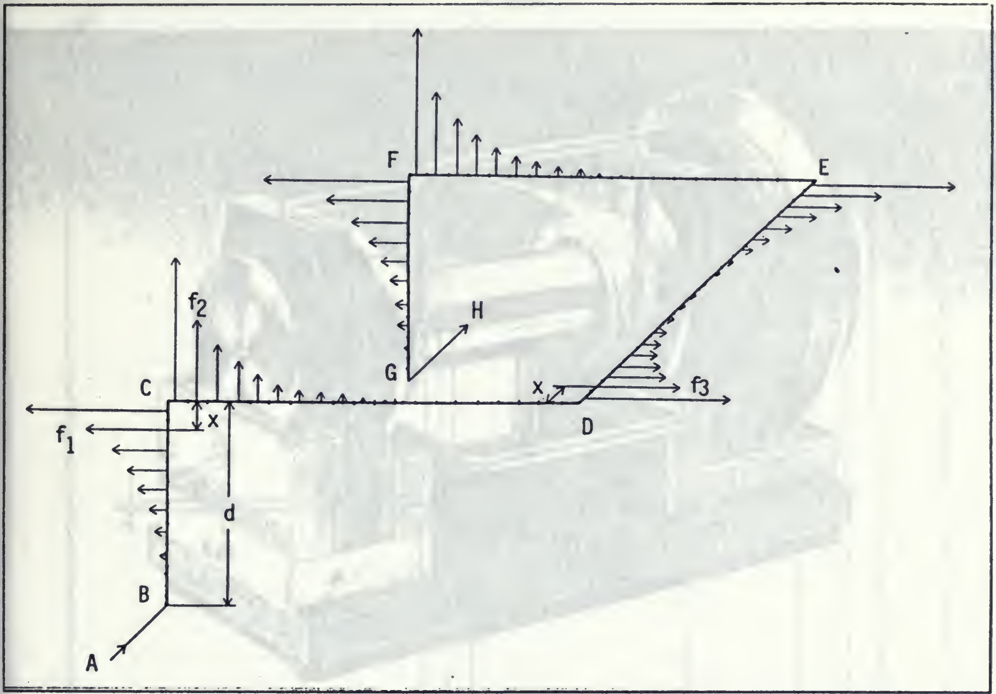
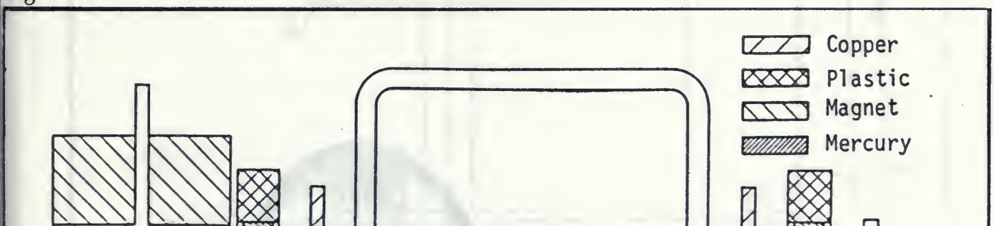


Fig. 1

Fig. 2



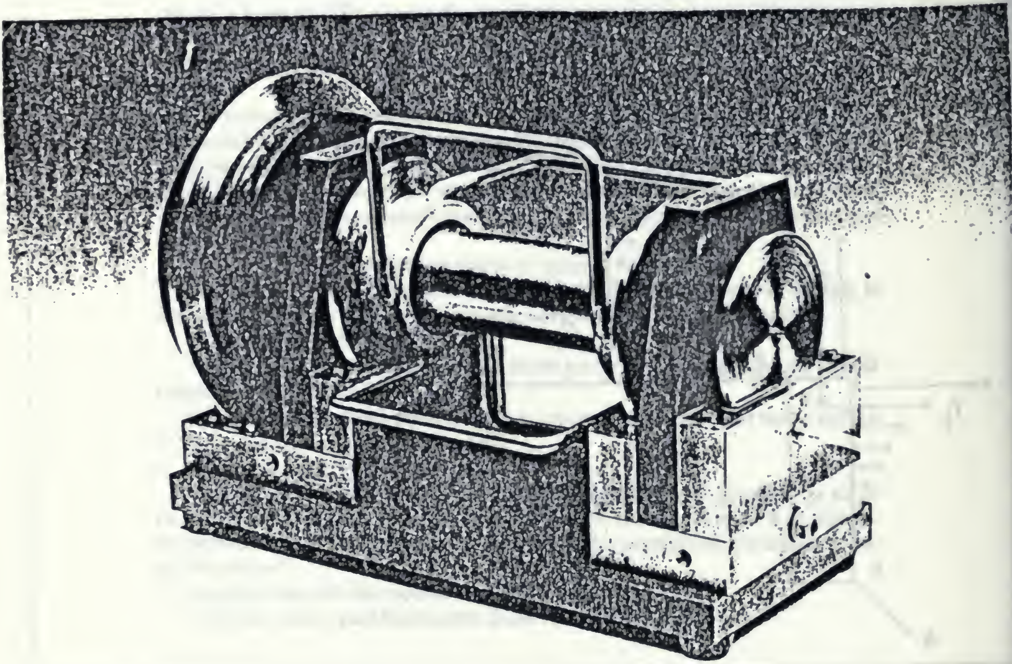


Fig. 3

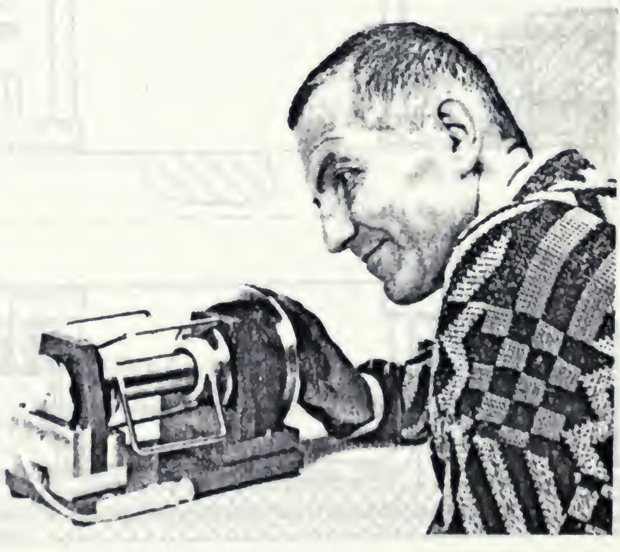


Fig. 4

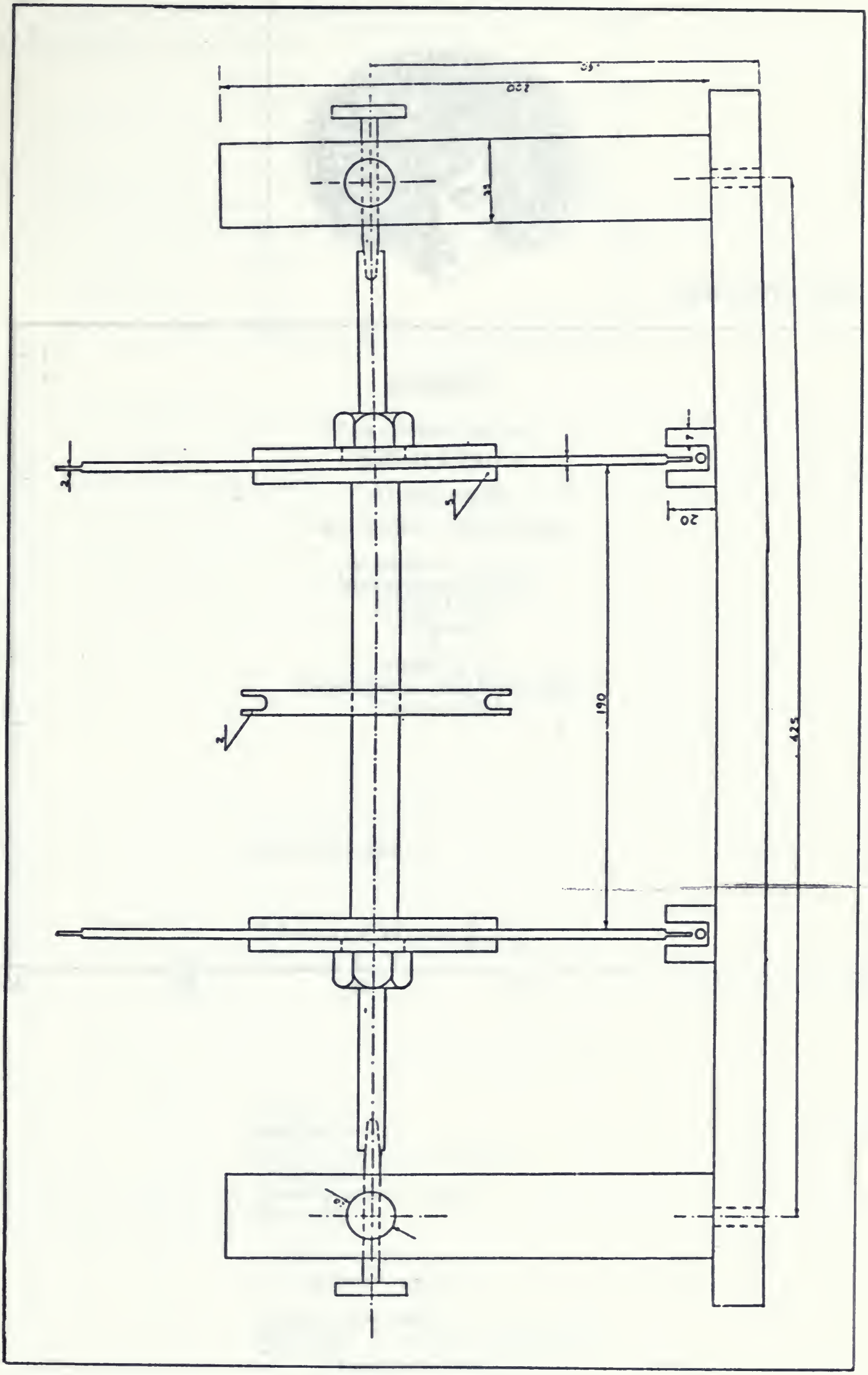


Fig.5

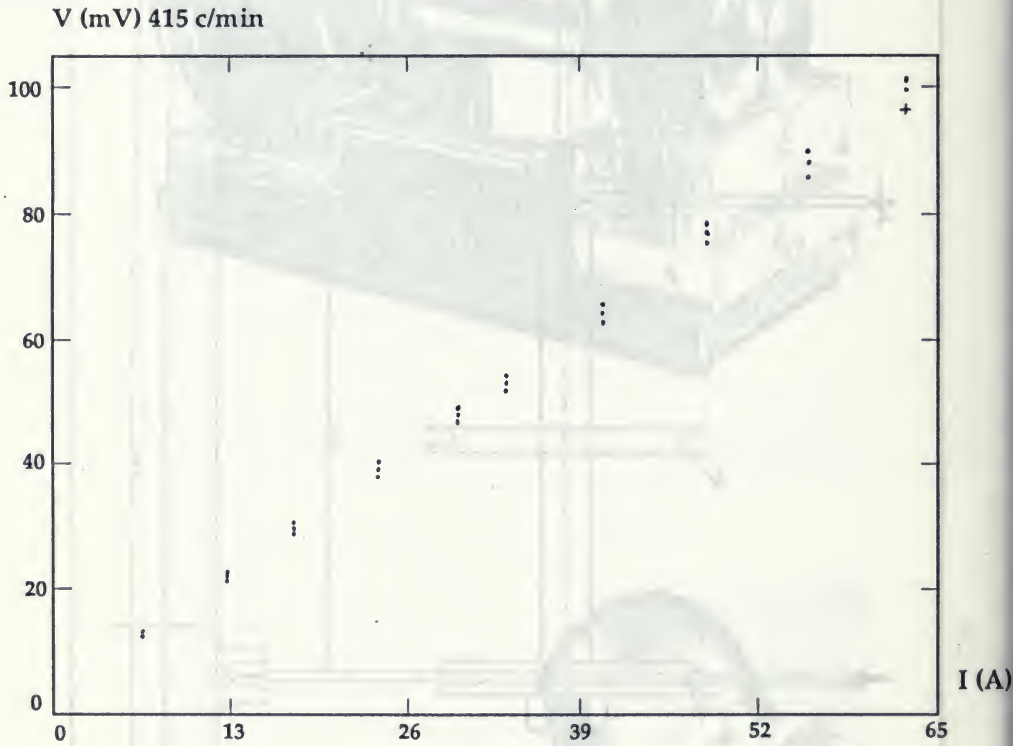


Fig. 6

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Repetition of Silvertooth's experiment for measuring the aether drift

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Abstract Silvertooth has announced that he has measured the Earth's absolute velocity using an optical laboratory experiment which can be considered as a variation of the quasi-Wiener experiment. I show that in the frame of my absolute space-time theory, or assuming axiomatically that the wavelength of light emitted in absolute space in the direction **n** by a source moving with a velocity **v** is $\lambda_n = \lambda/(1 + \mathbf{v}.\mathbf{n}/c)$, where λ is the wavelength emitted at right angles to **v**, and c is the velocity of light, neither the quasi-Wiener nor Silvertooth's variation can give a positive effect depending on the absolute velocity, v, of the laboratory, as these are standing waves experiments, where all absolute effects of first and second order in v/c are mutually annihilated. I have carried out a variation of Silvertooth's experiment where Silvertooth's transparent detectors are substituted by opaque detectors, making the execution so easy that the experiment can be mounted in a day in any optical laboratory, and I call it the quasi-Michelson experiment. I warn that if the geometry of the rays is not satisfactory, one observes spurious effects and their attribution to v is thus wrong.

Recently Silvertooth[1], carrying out a variation of the quasi-Wiener experiment (the term "quasi-Wiener experiment" and the relevant theory are given by me[2,3]), succeeded, as he asserts, in measuring the laboratory's absolute velocity to a very high accuracy. Let me note that Wiener[4] measured the light wavelength for the first time directly by producing standing waves of light and letting them act on a photographic film. If a similar method is used for measurement of the Earth's absolute velocity, I call it the quasi-Wiener experiment. Although a light source moving in absolute space (the aether) contracts the waves emitted in the direction of motion and dilates those emitted against the direction of motion, the standing wave pattern remains without change (to the first as well as to the second order in v/c). Thus I concluded that one cannot measure the Earth's absolute velocity using the quasi-Wiener experiment.

This can be shown by a simple calculation. Let a light source and an ideal mirror be placed on the x-axis of a frame K. If this frame is at rest in absolute space (or the absolute velocity is perpendicular to the x-axis), the electric intensities of the light waves incident and reflected by the mirror will be:

$$E_1 = E_{max}\sin(\omega t + kx), \quad E_2 = E_{max}\sin(\omega t - kx) \qquad (1)$$

where E_{max} is the amplitude of the electric intensity, ω is the angular frequency and k is the angular wavenumber. The time t is registered on a clock attached to frame K and x is the distance from the frame's origin to the point of observation of the electric intensity. The mirror has a larger abscissa than the source.

The incident and reflected light waves will interfere. For the electric intensity of the standing waves we obtain:

$$E = E_1 + E_2 = 2E_{max}\sin(\omega t)\cos(kx) \tag{2}$$

Suppose now that frame K is set into motion in absolute space with a velocity v in the x-direction (or that we rotate the moving frame K, so that its velocity v becomes parallel to the x- axis). Instead of ω and k in equations (1), we have now to write:

$$\omega_{1,2} = \omega, \text{ and}$$
$$k_{1,2} = 2\pi/\lambda_{1,2} = (2\pi/\lambda)(1 \pm v/c) = k(1 \pm v/c) \tag{3}$$

where λ is the wavelength of light for the case where K is at rest in absolute space (or the velocity of K is perpendicular to the x-axis) and $\lambda_{1,2}$ are the light wavelengths to and fro for the case where K moves with a velocity v in a direction parallel to the positive direction of the x-axis. Equations (3) are deduced in refs.2 and 3, where I show that they are exact within an accuracy of any order in v/c. Instead of equations (3) the classical wave theory predicts $\omega_{1,2} = \omega$, $\lambda_{1,2} = \lambda(1 \mp v/c)$, while the theory of special relativity predicts $\omega_{1,2} = \omega$, $\lambda_{1,2} = \lambda$.

In order to avoid my absolute space-time theory, then one has to take the equalities (3) as "axiomatic". Thus I shall analyse the quasi-Wiener experiment on the grounds of the axiomatical assertion that if a light source moves in absolute space with a velocity v and emits light whose trajectory makes an angle θ with respect to the trajectory of the source, the light wavelength will become deformed to $\lambda_\theta = \lambda(1 + v\cos\theta/c)$, where λ is the wavelength at right angles to the source's trajectory. In the moving laboratory, the wavelengths have exactly the same lengths as in absolute space and the angle between the respective trajectories is the same. The first equality (3) is obviously valid, as if a source and an observer move together, then the number of regular "signals" emitted by the source in a certain time interval is equal to the number of the "signals" received by the observer in an equally long time interval, as "signals" can be neither "lost" nor "generated".

Thus according to equalities (3), the electric intensity of the standing light waves will be given by the following equation:

$$E = E_1 + E_2 = 2E_{max}\sin\{\omega(t + vx/c^2)\}\cos(kx) \tag{4}$$

instead of by equation (2).

Hence the distances between the nodes of the standing waves when the Wiener experiment is performed in a frame at rest and in motion with respect to absolute space will be exactly the same, and not even second-order differences in the pattern can be observed. The only difference is the following. When the laboratory is at rest in absolute space (or its velocity is perpendicular to the direction of light propagation), E takes its maximum at all antinodes (*i.e.*, for $x = n\pi/k$, where n is an integer) at the same moment, and when the velocity of the laboratory is parallel to the direction of light propagation, E takes its maximum at the different antinodes at different moments. For a given moment t, the electric intensity in equation (4) obtains its maximum at the antinodes with coordinates near to $x = \{(2n + 1)\pi/2\omega - t\}(c^2/v)$, while for this moment t it is zero at the antinodes with coordinates near to $(n\pi/\omega$ -

$t)(c^2/v)$. This is the only effect which is offered by the quasi-Wiener experiment and (as I wrote in refs.2 and 3) I was sceptical about a possibility for its experimental verification.

Note that the null result in the historic Michelson-Morley experiment shows that the quasi-Wiener experiment should not reveal any directional dependent second-order effect in v/c. Indeed, if the standing waves were to have different lengths (within terms of second order in v/c) in the two cases where the pattern is parallel and where it is perpendicular to the absolute velocity, different numbers of wavelengths would be placed in the Michelson-Morley interferometer between the semi-transparent mirror and the two mirrors placed at equal distances from it in parallel and perpendicular directions to the absolute motion. This would lead to a positive effect in the Michelson-Morley experiment which, as we know, has not been observed.

Thus there are no possibilities for measurement of the "one-way" light wavelength. One always measures the lengths of standing waves, *i.e.*, the "two-way" light wavelength, where all first and second order effects are cancelled (as this is the case also when measuring the two-way light velocity).

Silvertooth now reports[1] having made a modified quasi-Wiener experiment which, according to him, allows the measurement of the laboratory's absolute velocity, obtaining figures almost identical with those obtained in my "coupled shutters" experiment[5] and near to those obtained by measurements of the slight anisotropy of the cosmic background radiation[6,7].

At first, when I heard about Silvertooth's experiment from private correspondence, I was deeply impressed. Seeing that his quasi-Wiener experiment, where transparent photodetectors must be used, is very difficult to repeat, I modified Silvertooth's method to an experiment with opaque photodetectors and called it the quasi-Michelson experiment, as it represents a certain variation of the historic Michelson-Morley experiment. Silvertooth's quasi-Wiener experiment takes months to construct, while my quasi-Michelson experiment can be mounted in a day in any well-equipped optical laboratory. I carried out such an experiment on the 2, 3 and 4 January 1987 and got the impression that there was an effect. However, more careful analysis later (see the end of this article) led me to conclude that in this experiment there is definitely no effect.

I shall now show that the analysis of the Silvertooth's experiment leads to a null result as in almost all high-velocity optical experiments where a Newtonian time synchronisation is not realised[2,3]. Nevertheless, I consider that Silvertooth's experiment deserves attention. Perhaps I have not understood Silvertooth's method and my repetition is not a physically adequate variation of his experiment. I am, however, firmly persuaded that his method is ineffective and only by realising a Newtonian time synchronisation with the help of a rotating axle, can one measure the Earth's absolute velocity by an optic experiment in a closed laboratory, as I did twice[5,8,9].

I shall describe Silvertooth's experiment as I understand it and then I shall present my quasi-Michelson experiment.

Figure 1 shows Silvertooth's set-up. Light coming from a He-Ne laser (λ = 6,328 Å) is split by a semitransparent mirror M_1 into two beams which, after being reflected by mirrors M_2, M_3, M_5, respectively, M_4, M_6, cross the detector D_1 representing a thin transparent photoelectric sensitive surface (about 500 Å) deposited on a glass plate[10].

The two oppositely propagating light beams interfere and produce standing waves. When the laser with mirrors M_1 and M_2 is mounted on a platform which is moved a distance Δ to the right, the standing waves pattern will be shifted around the ring accordingly.

Figure 2(a) shows what will occur in absolute space, *i.e.*, when the laboratory's absolute velocity is zero. If the point of separation M (*i.e.*, mirrors M_1 and M_2 in Figure 1) is at the initial position and the relation between the light wavelength and the geometry of the ring is as shown in Figure 2(a), then there will be an antinode at the detector D (*i.e.*, the detector D_1), and thus maximum illumination and consequently maximum photoelectric current. When displacing the point of separation M to the position M' over a distance $\Delta = \lambda/4$, points m' and n' (which correspond to points m and n) will "come" to the detector and there will be a node (minimum illumination). Figure 2(b) shows what will happen when the laboratory moves with a velocity $v = c/2$ to the right. According to my theory[2,3], the light velocity along and against the direction of motion of the laboratory is given by a formula similar to formula (3) for the wavelength, namely $c_{1,2} = c/(1 \pm v/c)$, which is also valid within an accuracy of any order in v/c. Thus we shall have for the

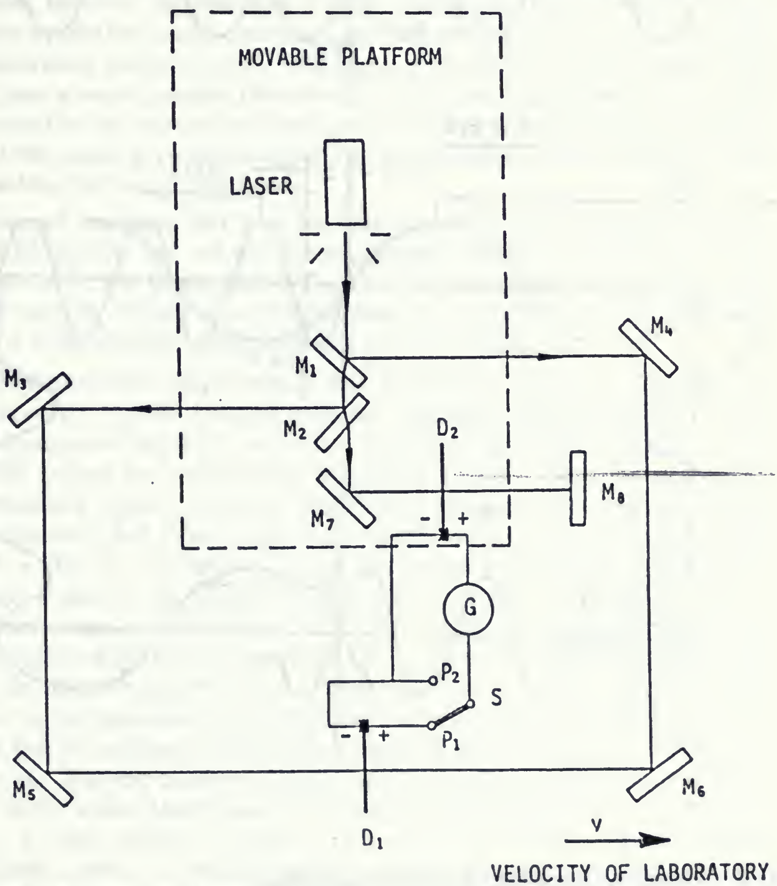


Figure 1 *Silvertooth's variation of the quasi-Wiener experiment.*

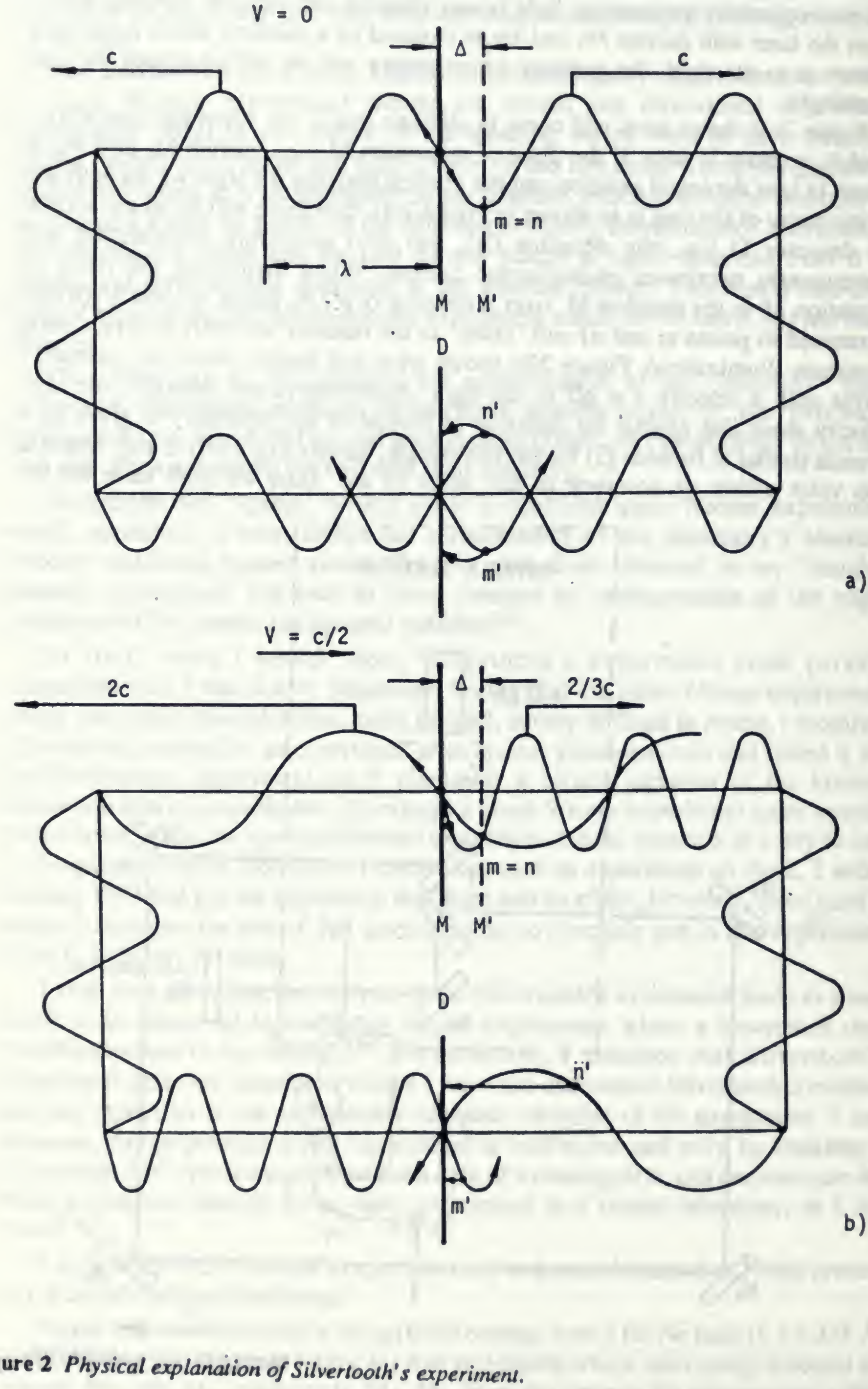


Figure 2 *Physical explanation of Silvertooth's experiment.*

laboratory light velocity along and against the direction of motion $c_1 = 2/3c$, $c_2 = 2c$, and for the respective wavelengths $\lambda_1 = 2/3\lambda$, $\lambda_2 = 2\lambda$. By displacing the point of separation M over the same distance $\Delta = \lambda/4$ points m' and n' (which correspond to points m and n) will "come" to the detector D and Silvertooth supposes that there will be an illumination different from minimum, as he writes (ref.1, p.5):

"If the translating member (*i.e.*, the point of separation of the light beams M - S.M.) moves towards M_3 an amount λ, then the wave impinging on D_1 by the route M_3 will advance less than a wave ($\lambda_2 > \lambda$), and the wave impinging on D_1 by the route M_4 will retard more than a wave ($\lambda > \lambda_1$). Thus, the two waves will remain in the same relative phase, but the standing wave pattern will have shifted with respect to the photocathode of the detector D_1 by a first order amount $\delta = \lambda(v/c)$."

This assertion which represents the core of the experiment is not true. At the motion of M over a distance $\Delta = \lambda$, the standing waves pattern at D_1 changes exactly with two antinodes. Indeed, when shifting M over a distance $\Delta = \lambda/4$ in Figure 2(b), the vectors of the electric intensity of the two beams at D which had the same phases at the initial position, producing an antinode, obtain a difference of the phases π, and thus produce a node, exactly as in the case 2(a). Figure 2(b) shows this clearly.

Silvertooth, however, supposes that if there were an antinode at D and one wishes to have again a (third) antinode, one has to shift the moving platform over a distance $\lambda \pm \lambda v/c$ (Silvertooth does not specify which sign, plus or minus, is to be taken). Then Silvertooth puts a second similar photodetector D_2 between the mirrors M_7 and M_8 which is crossed by the going to and fro light beams and where the distance between the nodes of the standing waves pattern at rest and on motion of the apparatus is the same (this is true, as formula (4) shows).

So Silvertooth supposes that if at the initial position of the platform there are antinodes at D_1 and D_2 and one moves the platform, then after a certain shift there will be a node at D_1 and an antinode at D_2. From the equation $2n(\lambda \pm \lambda v/c)/4 = (2n \pm 1)\lambda/4$, Silvertooth obtains $n = c/2v$ and since $n = \Delta/(\lambda/2)$, he finds $v = c\lambda/4\Delta$, considering n as the number of the antinodes over the distance Δ.

To clarify the essence of high-velocity light kinematics, I present in Figures 3 and 4 the graphs of the electric intensities of two oppositely propagating light waves emitted by sources moving with a velocity v in absolute space (for simplicity's sake the sinusoidal curves are replaced by straigt-line curves). Figure 3 presents the electric intensities if light has an aether-Newtonian character of propagation[2,3], thus when the contracted and dilated light wavelengths are given by the formula (see above) $\lambda_{1,2} = \lambda(1 \mp v/c)$, where λ is the wavelength in a direction perpendicular to v. Figure 4 shows the graphs of the electric intensities if light has an aether-Marinov character of propagation[2,3], thus when the contracted and dilated light wavelengths are given by equation (3) $\lambda_{1,2} = \lambda/(1 \pm v/c)$. For a Newtonian light wave, the distance between two successive antinodes in a standing wave along the direction of the laboratory's absolute velocity is with $\lambda v^2/2c^2$ shorter than $\lambda/2$. One can see that the number of nodes along a track d prependicular to v will be with $2dv^2/\lambda c^2$ less than the number of nodes along a track d parallel to v. This was exactly the effect which Michelson and Morley were searching for in their famous experiment. As they could not detect such an effect, instead of introducing the phantasmagoric Lorentz contraction or the senseless theory of relativity, one had simply to accept the aether-Marinov character of light propagation defined by the above simple formulas. Indeed, Figure 4 shows that for a Marinov light wave the

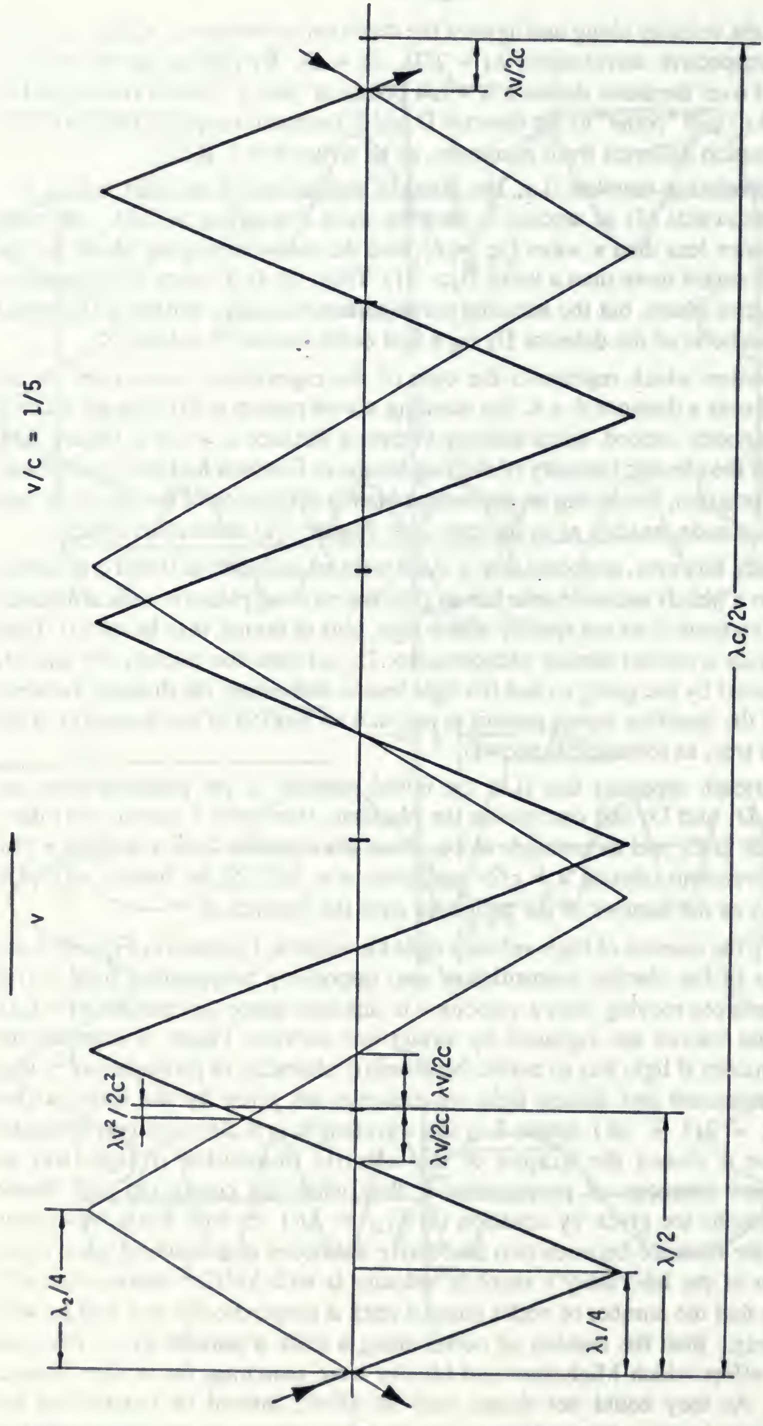


Figure 3 *Newtonian standing waves in a moving laboratory.*

Figure 3 *Newtonian standing waves in a moving laboratory.*

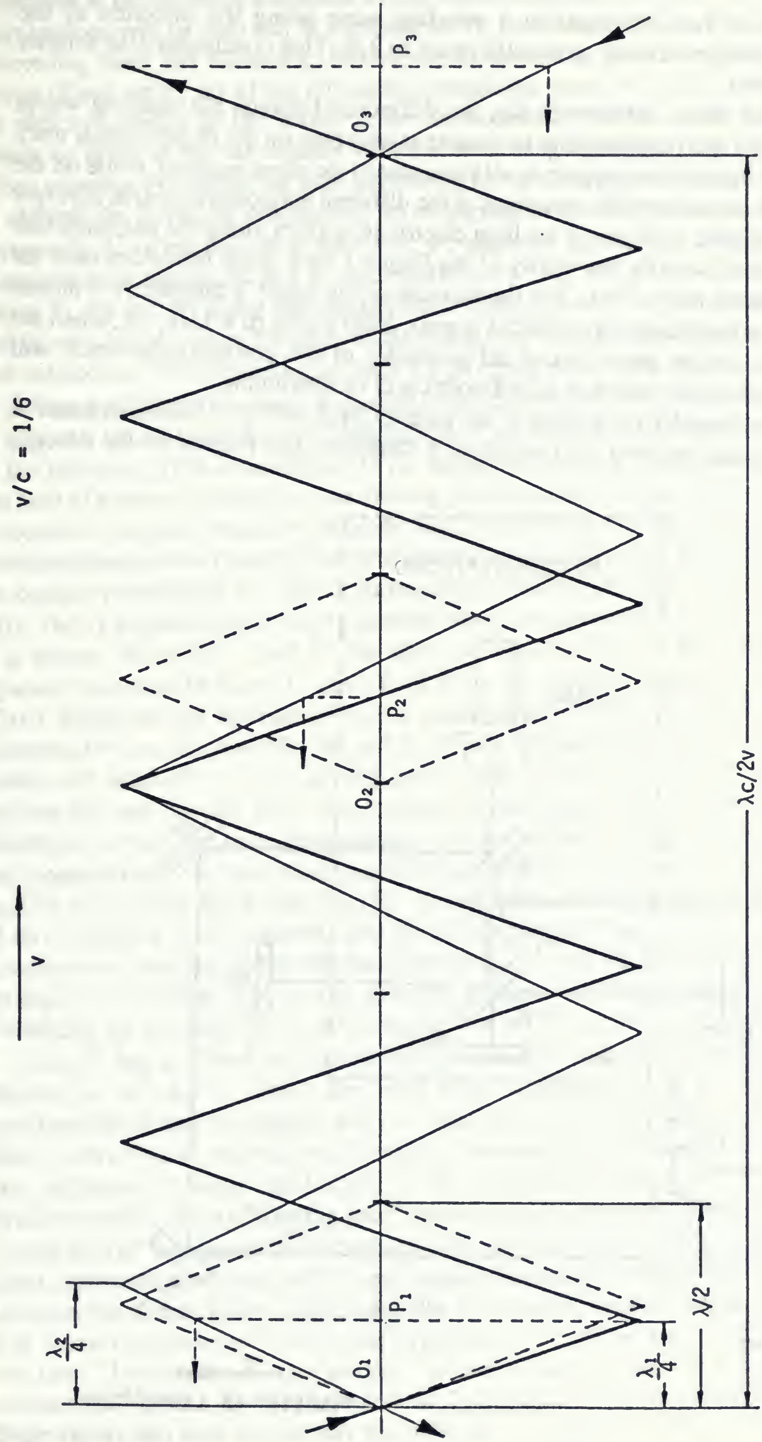


Figure 4 *Marinov standing waves in a moving laboratory.*

Figure 4 *Marinov standing waves in a moving laboratory.*

distance between two antinodes in a standing wave along the direction of the laboratory's absolute velocity is exactly equal to $\lambda/2$. This conclusion also follows from equation (4).

As I showed above mathematically, the difference between the standing waves along the parallel and perpendicular to v tracks is only one: on the perpendicular track the maximum illuminations appear at *all* antinodes at the same moment, while on the parallel track the maximum illuminations at the different antinodes appear at *different moments.* I indicated in Figure 4 the light electric intensities along the perpendicular track with dotted lines (for the clarity of the Figure I drew these intensities only for the first and fourth half-waves). For the moment of the figure's snapshot, the phases of the electric intensities at all antinodes is zero. After a time $\Delta t = \lambda/4c$, i.e., when the phases of the electric intensities at all antinodes of the perpendicular track will become 90°, the illuminations at all antinodes will be maximum.

Let us now consider the picture at the parallel track which is shown in detail in Figure 4. For the moment of the figure's snapshot, the phases of the electric

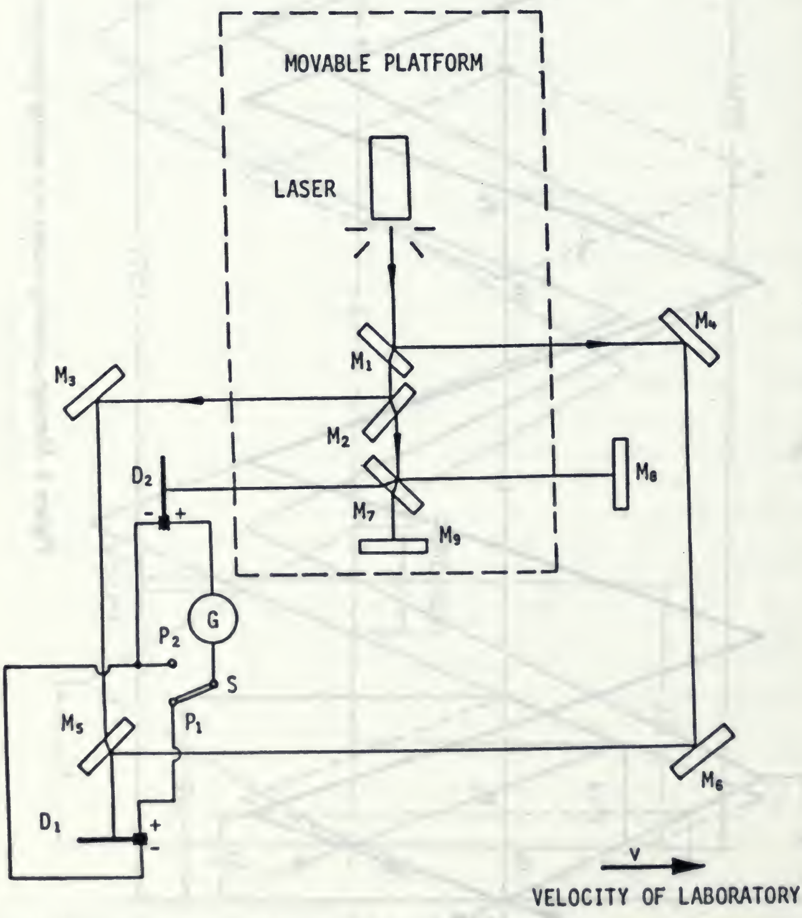


Figure 5 *Marinov's variation of Silvertooth's experiment (a quasi-Michelson experiment).*

intensities at the different antinodes will be different: at the antinodes O_1 and O_3 the illuminations will be zero and at the antinode O_2 the illumination will be maximum. Proceeding from this difference, Silvertooth supposes that by shifting (jittering) the source of one wave, say of the leftwards propagating wave, he will be able to reveal the different phases of the waves at the antinodes O_1 and O_2. Unfortunately this cannot be done, as we can register with our measuring apparatus only the square of E (see equation (4)) where the time depending factor disappears. Figure 4 shows that by shifting the leftwards propagating wave slightly to the left, the phase differences between both waves (which is the effect we measure, as at phase difference 0° the illumination is maximum and at phase difference 180° the illumination is null) at points P_1, P_2 and P_3 along the parallel track change exactly with the same amount and this change is exactly the same as the change for the same position between node and antinode on the perpendicular track for an equal shift of the one wave.

I have modified Silvertooth's quasi-Wiener experiment to the experiment shown in Figure 5 which I call the quasi-Michelson experiment. I let the laser be stationary in the laboratory (this is not shown in the figure) directing its light towards M_1 with the help of a mirror mounted on the moving platform and I exchanged the transparent detectors for opaque detectors (photodiodes). To this end I replaced mirror M_5 by a semitransparent mirror having the same inclination as mirror M_3 and beneath it I put an opaque photodiode D_1 whose photosensitive surface looked upwards (towards M_5). Then I replaced mirror M_7 by another semitransparent mirror and I put beneath it a mirror M_9 solidly fixed to the platform which reflected the incoming light upwards (towards M_7) and to the left of M_7 I put another opaque photodiode D_2 (fixed solidly to the laboratory) whose photosensitive surface looked to the right (towards M_7), so that M_7, M_8, M_9 and D_2 built a Michelson interferometer. Now the nodes and antinodes of the standing waves were produced on the semitransparent mirrors M_5 and M_7 and there was no need for the light beams to pass through the detectors. To have the same illuminations over the detectors D_1 and D_2 when shifting the movable platform, as it must be according to the presented above theory, the light rays M_1M_4, M_2M_3, and M_7M_8 must be exactly parallel to the motion of the platform. If this condition is not realised, then by shifting the platform one can obtain non-synchronous changes of the illuminations over D_1 and D_2 and one can treat this wrongly as an effect due to the absolute motion. I warn the people, who will eventually try to check Silvertooth's results not to fall into the same trap.

Kelly[11] has analysed my interferometric "coupled mirrors" experiment, raising doubts as to whether, with the help of a rotating axle, a Newtonian time synchronisation can be realised. Kelly's criticism is based on the assumption that two disks, with a "mark" on their rims fixed to a common axle and rotating rigidly, present two different "clocks" and applies the complicated analysis of the "clock synchronisation" to my "rotating axle" experiments. However, the essence of all my "rotating axle" experiments[5,8,9] is exactly the fact that such a rotating axle with two disks represents one clock with a large space dimension, and the "synchronisation" between the disks-clocks is automatically Newtonian. Prokhovnik (following Ives and Janossy) introduces[12] *ad hoc* the hypothesis of the "Lorentz twist" (I introduced the term "Lorentz twist", by analogy to the *ad hoc* hypothesis of the "Lorentz contraction"[13]) with the aim to make an Einsteinian "desynchronisation" between those clocks and save in this way the principle of relativity. But my "rotating axle" experiments show that such a "Lorentz twist" does not exist and the disks rotate synchronously when rotating the axle in a plane in which the laboratory's absolute velocity lies. Thus the answer to Kelly's doubts is given by Nature itself. Everybody who will repeat my "rotating axle" experiments will persuade him that there is an effect. My "coupled shutters" experiments[5] gave in February 1984 the following figures for the Earth's absolute velocity and for the equatorial coordinates of its apex:

$$v = 360 \pm 40 \text{ km s}^{-1}, \delta = -24° \pm 7°, \alpha = 12.5\text{h} \pm 1\text{h}$$

References

1 Silvertooth, E.W. *Specul. Sci. Technol.*, **10**, 3 (1987).
2 Marinov, S. *Eppur si muove* (C.B.D.S, Bruxelles, 1977, 3rd edn.). East-West, Graz (1987).
3 Marinov S. *Classical Physics*. East-West, Graz (1981).
4 Wiener, O. *Ann. Phys.*, 40, 203 (1890).
5 Marinov, S. *The Thorny Way of Truth*, Part II. (1984). East-West, Graz (1987, 3rd edn.).
6 Muller, R.A. *Scient. Am.*, 238, 64 (1978).
7 Cheng E.S. *et al.*, *Astrophys. J.*, 232, 139 (1979).
8 Marinov, S. *Czech. J. Phys.*, B24, 965 (1974).
9 Marinov, S. *Gen. Rel. Grav.*, 12, 57 (1980).
10 Silvertooth, E.W. and Jacob, S.F. *Appl. Opt.*, 22, 1274 (1983).
11 Kelly, E.M. *Opt. Lett.*, 11, 697 (1986).
12 Prokhovnik, S.J. *Found. Phys.*, 9, 883 (1979).
13 Marinov, S. *Specul. Sci. Technol.*, 1, 520 (1978).

At Prof. Bartocci's conference "I FONDAMENTI DELLA MATEMATICA E DELLA FISICA NEL XX SECOLO: LA RINUNCIA ALL'INTUIZIONE", Perugia, 27 - 29 September 1989.

Some of the non-Italian participants (from the left to the right): S. Marinov, J. Cure, Mrs. Graneau, Mrs. Wesley, J. P. Wesley, Mrs. Pappas, P. Graneau, T. Theocharis.

PHYSIKALISCHE ZEITSCHRIFT

No. 19. S. 585 — 1. Oktober 1904. — 5. Jahrgang.

Redaktionsschluss für No. 20 am 5. Oktober 1904.

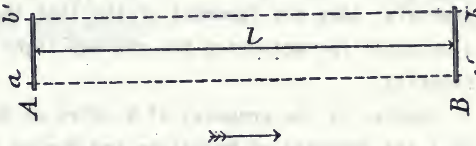
Über einen Versuch zur Entscheidung der Frage, ob sich der Lichtäther mit der Erde bewegt oder nicht.

Von W. Wien.

Auf der diesjährigen Versammlung der British Association in Cambridge hatte ich über die Möglichkeit gesprochen, die für die Elektrodynamik fundamentale Frage, ob sich der Äther mit der Erde bewegt oder nicht, dadurch zu entscheiden, dass man die Lichtgeschwindigkeit mit einem Lichtstrahl misst, der die Entfernung zwischen zwei Punkten nur in einer Richtung zurücklegt, ohne wieder zurückzukehren.[1] Für die Ausführung dachte ich an die Foucaultsche Methode, bei deren Anwendung zwei mit gleicher Geschwindigkeit rotierende Spiegel benutzt werden müssten. Es sollte dann die Lichtgeschwindigkeit gemessen werden einmal, wenn der Strahl in derselben Richtung wie die Erde sich zwischen den beiden Spiegeln bewegt und dann, wenn er entgegengesetzt zur Erdbewegung läuft.

Vielleicht wäre indessen die Fizeausche Methode für die Ausführung geeigneter. Denken wir uns zwei möglichst identische Zahnräder A, B in grosser Entfernung parallel aufgestellt. Ferner seien a und b zwei möglichst gleiche Lichtquellen, deren Licht durch die Zahnlücken hindurchgeht. Bei ganz symmetrischer Stellung beider Räder muss, solange sie sich nicht drehen, die bolometrisch gemessene Lichtmenge bei a' ebenso gross sein wie bei b', wenigstens, wenn Grössen vernachlässigt werden, die von der Ordnung des Quadrats des Verhältnisses der Erdgeschwindigkeit v zur Lichtgeschwindigkeit c sind.

Bewegt sich der Äther mit der Erde, so darf auch bei gleichmässiger Bewegung beider Räder in den bei a' und b' anlangenden Lichtstärken kein Unterschied auftreten. Die Kontrolle für die gleiche Geschwindigkeit beider Räder hätte man in der Konstanz des hindurchgehenden Lichtes oder in bekannten stroboskopischen Methoden.



Ruht der Äther in Bezug auf die Erde, so ist die Zeit, die das Licht braucht, um von a nach a' zu gelangen, wenn l die Entfernung der Räder bezeichnet

$$\frac{l}{c-v},$$

wenn die Erde in der Richtung aa' geht, und

$$\frac{l}{c+v}$$

ist die Zeit, die der Strahl braucht, um von b nach b' zu gelangen.

Es muss also eine Unsymmetrie durch die Erdbewegung hineingebracht werden und die Lichtstärken in a' und b' müssen verschieden sein, weil der Lichtstrahl aa' das Rad B in einer anderen Stellung antrifft, wie der Strahl bb' das Rad A.

Dass der Versuch nicht unausführbar ist, scheint mir daraus hervorzugehen, dass die Genauigkeit in der Bestimmung der Lichtgeschwindigkeit die Grenze bereits erreicht hat, die hier erforderlich ist, nämlich

$$\frac{1}{5000}$$

des Betrages. Freilich wirkt der Umstand erschwerend, dass man es mit zwei Zahnrädern zu thun hätte, deren Umlaufsgeschwindigkeit in Übereinstimmung zu bringen ist. Andererseits braucht der Synchronismus nur sehr kurze Zeit anzudauern und man braucht keine absolute Messung, sondern nur die Feststellung eines Unterschiedes zwischen beiden Strahlen.

Abgesehen von seiner Bedeutung für die Elektrodynamik wäre dieser Versuch der erste, mit dem eine absolute Geschwindigkeit, ohne Beziehung auf festliegende Punkte, gemessen würde.

Würzburg, September 1904.

(Eingegangen 10. September 1904.)

1) Vergl. das Referat in dieser Zeitschr. 5, 604, 1904.

MARINOV'S COMMENTS ON THE PRECEDING PAPER BY W. WIEN

Many persons have proposed to measure the one-way light velocity by two independently rotating cog-wheels. As far as I know, the first such proposal is done by Michelson and Morley in their historical paper reporting the results of their famous interferometric experiment which was published in 1887 in TWO journals: THE PHILOSOPHICAL MAGAZINE and THE AMERICAN JOURNAL OF SCIENCE. However, as the relativists today do not read old journals, they are ignorant of the fact that Michelson and Morley first have presented a proposal for measuring the one-way light velocity and consequently the Earth's absolute velocity.

Similar is the proposal of W. Wien on the preceding page, although I must emphasize that the proposal of Michelson and Morley is presented much better.

Recently my friend Prof. J. P. Wesley sent me a paper on a similar proposal with a detailed technical analysis.

I firmly defend the opinion that the one-way light velocity, thus the Earth's absolute velocity, can be not measured with two independently rotating shutters (cog-wheels), AS ONE DOES NOT KNOW THE "PHASE DIFFERENCE" between the shutters. Only when the cog-wheels are fixed to a common rotating shaft, their phase is fixed and by rotating the apparatus in the plane of the Earth's absolute velocity one can measure it. Such an experiment I called the "coupled shutters" experiment and I carried it out with success in 1984 (see TWT-II, p. 68). The experiment with the independently rotating cog-wheels was called by me the "uncoupled shutters" experiment. In my book CLASSICAL PHYSICS, vol. III, § 50 B, I analysed in detail all possible variations of the "uncoupled shutters" experiment and I came to the conclusion that by its help one is unable to measure the Earth's absolute velocity.

Prof. Wesley thinks that the rate of a clock does not depend on its absolute velocity, and when the system of two clocks rotates, due to the diurnal rotation of the Earth, one will keep this phase difference constant and thus the absolute Earth's velocity will be easily measured. According to my concepts, during such a rotation the time dilation of the clocks will be such that the quantity of light going through both choppers will remain always the same, as the case will be if the Earth's center is at rest in absolute space.

After receiving the paper of Prof. Wesley, I wrote him my opinion on the "uncoupled shutters" experiment (which, of course, he already knew well) but I added that only the experiment can decide whether he is or I am right, and I asked him whether he agrees that I publish his proposal in TWT-VII. Such an experiment with two independently rotating cog-wheels is today technically not at all difficult and the accuracy which it offers is high enough. But, strangely enough, no one of the big physics laboratories has carried it out. Neither in the past has someone tried to realize such an experiment. Thus the publication of Wesley's proposal could direct the attention of the scientific community to this interesting kind of experiment.

In a phone conversation Prof. Wesley said me that his paper is due to appear in PHYSICS ESSAYS and thus he cannot publish it also in TWT-VII.

I present here the abstract of Wesley's paper. I shall be happy if after its publication in PHYSICS ESSAYS a world-wide discussion on his proposal will begin leading eventually to a realization of the "uncoupled shutters" experiment, which, in the case of giving positive result, will show that there is no time dilation of the periodic processes due to the absolute velocity of the systems (I affirm in my absolute space-time theory that such time dilation does exist).

Proposal to Measure Absolute Velocity Using Two Independent Clocks

J. P. Wesley

Abstract

A toothed wheel rotated by an electric clock motor chops a laser beam. A second wheel a distance L *from the first again chops the beam. The resultant intensity is a linear function of the angle through which the second wheel rotates during the time light travels the distance* L, $\Delta t = L/(c - v_L)$, *where* v_L *is the absolute velocity of the laboratory in the direction* L. *Two beams are oriented so that the chopping increases the intensity of one and decreases the intensity of the other. Comparing these two intensities with the intensities of two beams traveling in the opposite direction yields the desired absolute velocity* $2v_L = c^- - c^+$ *directly electronically. The correct relative angular phase, determined by the intensities, is obtained by rotating one of the wheels together with its motor. The magnitude and direction of the absolute velocity of the solar system is obtained by fixing* L *in the north-south direction at a northern latitude and measuring* v_L *over a 12 hour period.*

3 Oct. 1980

Querido amigo Stefan

Iremos a Bogotá!

In 1980 Prof. Wesley accepted a vacant professorship in Bogota about which I have informed him, however after going to Columbia, he remained abhorred by its quasi-fascist political system and renounced to the professorship. He sent me the above sketch before starting for Bogota, when Columbia had for him and for the members of his family only the face of an amiable lama. The picture above shows that Paul surely is the best painter between the physicists, as, of course, he is also the best physicist between the painters.

The lama's riders are: Benjamin, Julia, Gabriele, Paul and Karlchen.

Relativity and electromagnetism: The force on a magnetic monopole

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On the occasion of the 100th anniversary of the first publication, by Oliver Heaviside, of what is now known as the Lorentz force law in electromagnetic theory, the analogous force law for magnetic monopoles is examined. Its relevance and limitations in calculating the force and torque on small current loops are discussed, and both its heuristic and practical uses are demonstrated.

I. 100 YEARS OF LORENTZ FORCE

The year 1989 marks the 100th anniversary of the first publication, by Oliver Heaviside, of the well-known formula[1] $\mathbf{F} = q\mathbf{v}\times\mathbf{B}/c$ for the mechanical force on a point charge q moving with velocity $\mathbf{v}$ through a magnetic field $\mathbf{B}$. Generalized to $\mathbf{F} = q(\mathbf{E} + \mathbf{v}\times\mathbf{B}/c)$ (in Gaussian units), it now constitutes the "fifth axiom" of electromagnetism, along with Maxwell's four equations, and is usually referred to as the *Lorentz force law*. I would like to take this occasion to make some remarks on the analogous formula (but note the minus sign!)

$$\mathbf{F} = q_m(\mathbf{B} - \mathbf{v}\times\mathbf{E}/c) \tag{1}$$

for the force on a magnetic charge q_m (a monopole), which has been variously discussed, e.g., by Sommerfeld,[2] but to my mind not as sympathetically as it deserves to be.

Einstein, even before inventing special relativity in 1905, "was convinced that the (Lorentz) force acting on a charged body in motion through a magnetic field was nothing else but an electric field (in the body's rest frame),"[3] and so it turned out to be. This shows the intimate connection of Heaviside's formula with relativity. We shall therefore begin with an excursion into that theory.

II. RELATIVITY AND ELECTROMAGNETISM

Einstein's relativity principle asserts that any physical law valid in one inertial frame is valid in all inertial frames. (In particular, this holds for the five basic axioms of electromagnetism.) Thus, when a given experiment is observed from several different inertial frames, its outcome must be explainable in each of these by using the same totality of laws. Consider, then, the application of this principle to the following two electromagnetic experiments:[4]

(1) An electric charge moving through the $\mathbf{B}$ field of a stationary magnet in general (i.e., unless it moves tangentially to a field line) experiences a (Lorentz) force; referring our observations next to the instantaneous inertial rest frame of the charge, we see that a stationary charge must therefore experience a force when a magnet is moved in its vicinity.

(2) A stationary magnetic dipole (e.g., a compass needle) in general experiences a torque in the presence of a moving charge, since the latter creates a $\mathbf{B}$ field; transferring our observations once more to the inertial rest frame of the charge, we conclude that a magnetic dipole moving through a static electric field must experience a torque.

It is now natural to pose the problem whether these and perhaps other similar conclusions can be reached from Maxwell (i.e., standard electromagnetic) theory *without* appeal to relativity and, if so, at what cost in complication.

For problem 1 it would be tempting to use the "sixth axiom," our Eq. (1), if it were part of Maxwell theory. The magnet moving in the field of the charge is then immediately seen to experience a force, so that by Newton's law of action and reaction the charge must similarly experience a force due to the magnet. Problem 2 becomes even more immediately obvious by appeal to Eq. (1). However, whereas for problem 1 a little "trick" strictly within Maxwell theory will yield the result, we shall show that no nonrelativistic method will solve problem 2.

The "trick" for problem 1 is to use the Eulerian derivative of the vector potential $\mathbf{A}$, i.e., the time rate of change of $\mathbf{A}$ at a point moving with velocity $\mathbf{v} = dx_i/dt$,

$$\frac{d\mathbf{A}}{dt} = \frac{\partial \mathbf{A}}{\partial t} + \sum \frac{\partial \mathbf{A}}{\partial x_i}\frac{dx_i}{dt}. \tag{2}$$

Suppose a bar magnet is moved with uniform velocity $\mathbf{v}$ through an inertial frame. The vector potential $\mathbf{A}$ of its $\mathbf{B}$ field will then be constant along all comoving points, $d\mathbf{A}/dt = 0$. Thus, from the usual relation between $\mathbf{E}$ and $\mathbf{A}$ and Eq. (2),

$$\mathbf{E} = -c^{-1}\frac{\partial \mathbf{A}}{\partial t} = c^{-1}(\mathbf{v}\cdot\nabla)\mathbf{A},$$

and it is this nonzero $\mathbf{E}$ field that will set a stationary charge in motion as the magnet passes.

III. THE MONOPOLE LAW

As we have just seen, the monopole axiom (1) would be a handy tool in the solution of some electromagnetic problems. But, of course, since standard Maxwell theory denies the existence of monopoles ($\nabla\cdot\mathbf{B} = 0$), such an axiom at first sight seems superfluous. Nevertheless, the theory admits the existence of magnetic dipoles in the guise of current loops. (Here we shall think of realistic current loops, as in a copper wire, where the net charge in the rest frame of the wire is strictly zero.) Hence the theory must provide a means of calculating the torque on such a dipole when in motion. And indeed it does, since it is a well-defined problem in mechanics to evaluate the torque on a current loop as it moves through a static $\mathbf{E}$ field. However, *classical* mechanics yields unsatisfactory results. For the simplest case, when the plane of the loop is orthogonal to the direction of motion, the calculated torque is zero. For the force on each charge q, whether moving or not, is $q\mathbf{E}$, so the net force on any current element is zero. Classically this remains true even if the plane of the loop is not perpendicular to the motion, but then one might be tempted to mix in "some" relativity, allowing for the different length contractions of the positive and negative sets of charges in the wire.[5] Indeed this does give a torque, but in general too little.

Thus it is only *relativistic* mechanics that can—and indeed must—give the required torque. The actual calculation in the frame of the pure **E** field is tricky and involves not only the above-mentioned length contractions but also continuum mechanics somewhat along the lines of Tolman's lever.[6] However, if we are prepared to use full relativity, we might as well fall back on the archetypal relativistic technique, namely, transforming the far more easily obtainable[7] torque $\mathbf{m}\times\mathbf{B}$ in the rest frame of the current dipole **m** to the general frame. Even so, complications arise in the exact calculation, since the torque transforms awkwardly, being the 3×3 part of a 4×4 "world" tensor.

Far simpler than doing any of the above is the appeal to the monopole law (1), after replacing the current-loop dipole by a charge-pair dipole. Let us derive it from the basic assumption: A monopole q_m experiences a force

$$\mathbf{F} = q_m \mathbf{B} \tag{3}$$

when at rest. (This is certainly *consistent* with the torque on a stationary dipole being $\mathbf{m}\times\mathbf{B}$.) We must also assume that the measure q_m of a monopole is invariant, i.e., independent of its motion. Consider the usual two inertial frames S and S' in standard configuration (collinear x axes, parallel y and z axes, velocity of S' relative to S:v). Let a monopole q_m be at rest in S'. The background field $\mathbf{E}'$, $\mathbf{B}'$ acting on it in S' is the usual Lorentz transform of the field **E**, **B** in S, in particular,[8]

$$B'_1 = B_1, \quad B'_2 = \gamma(B_2 + vE_3/c),$$
$$B'_3 = \gamma(B_3 - vE_2/c), \tag{4}$$

with $\gamma = (1 - v^2/c^2)^{-1/2}$. By hypothesis, the force on the monopole in S' is $\mathbf{F}' = q_m\mathbf{B}'$. Transforming this force[9] to S and using (4), we find

$$F_1 = F'_1 = q_m B'_1 = q_m B_1,$$
$$F_2 = \gamma^{-1}F'_2 = \gamma^{-1}q_m B'_2 = q_m(B_2 + vE_3/c),$$
$$F_3 = \gamma^{-1}F'_3 = \gamma^{-1}q_m B'_3 = q_m(B_3 - vE_2/c). \tag{5}$$

With $\mathbf{v} = (v,0,0)$, we recognize Eqs. (5) to be equivalent to Eq. (1), the monopole law. (Of course, the Lorentz force law itself can be quite analogously derived from the basic law $\mathbf{F} = q\mathbf{E}$ in the rest frame, thus bearing out Einstein's pre-1905 "hunch" we mentioned earlier.)

IV. CONCLUSIONS

To what extent is a small ("point"-) charge-pair dipole equivalent to a small ("point"-) current-loop dipole? Both experience the same torque $\mathbf{m}\times\mathbf{B}$ when at rest in a given external field, as we have already noted. They also give *rise* to identical farfields.[10] By appeal to Newton's third law one might therefore be tempted to think that they must also *experience* the same force in a given external field **B**. However, in the framework of special relativity, Newton's third law is not valid—or even meaningful—in time-dependent fields. And, in fact, the forces are given by different expressions: $\mathbf{F} = \nabla(\mathbf{m}\cdot\mathbf{B})$ for the current loop,[11] and $\mathbf{F} = (\mathbf{m}\cdot\nabla)\mathbf{B}$ for the charge pair,[12] when at rest. These are equal *only* if $\nabla\times\mathbf{B} = 0$, i.e. (in vacuum), if $\partial\mathbf{E}/\partial t = 0$. The reason for the discrepancy is that the internal fields of the two kinds of dipole are different, and that these affect the forces experienced. A good way of seeing this is via the well-known formulas[13] giving the force either as a volume integral extended over the object in question or a surface integral extended over its surface, in terms of the total Maxwell stress tensor, to which the internal field of course contributes.

One may therefore replace small current loops with small charge pairs and apply to the latter the monopole law, *only* if one bears in mind the limitations spelled out above. When these limitations are exceeded, one must content oneself with regarding the results as approximate. (After all, $\nabla\times\mathbf{B} = c^{-1}\,\partial\mathbf{E}/\partial t$ is often small compared to $\nabla\mathbf{B}$.) The same applies to the use of Newton's third law in electromagnetism. For example, the force calculated by its use on the stationary charge in problem 1, though qualitatively correct, cannot be regarded as exact.

In sum, the monopole law furnishes a help to our intuition in predicting qualitatively the outcome of a large class of problems involving permanent magnets, current loops, and charges. It gives exact answers for the torque on small current loops and, under certain circumstances, also for the corresponding force.

ACKNOWLEDGMENTS

I wish to thank R. E. Harke for a very useful comment on Eulerian derivatives, and an unknown referee for spotting a serious flaw in an earlier version.

[1]Oliver Heaviside, "On the electromagnetic effects due to the motion of electrification through a dielectric," Philos. Mag. 27, 324–339 (1889), Eq. (4); cited in Sir Edmund Whittaker, *A History of the Theories of Aether and Electricity* (1910, Harper Torchbooks, New York, 1960), Vol. I, pp. 310 and 396. In 1881 J. J. Thomson had given the force as half that amount. Note that Heaviside writes AB and *V*AB for today's A·B and A×B, respectively. This paper is further remarkable for containing a derivation of the exact field of a uniformly moving point charge [Eq (29)] discovered by Heaviside the previous year.

[2]Arnold Sommerfeld, *Lectures on Theoretical Physics* (Academic, New York, 1952), Vol. III, p. 238.

[3]See R. S. Shankland, "Michelson–Morley experiment," Am. J. Phys. 32, 16–35 (1964).

[4]These are, in fact, Exercises 1.5 and 1.6 in W. Rindler, *Essential Relativity* (Springer-Verlag, New York, 1977), 2nd ed.

[5]A. P. French, *Special Relativity (The MIT Introductory Physics Series)* (Norton, New York, 1968), p. 260, or cf. Ref. 4, p. 104.

[6]See, for example, Wolfgang Rindler, *Introduction to Special Relativity* (Clarendon, Oxford, 1982), p. 164.

[7]John David Jackson, *Classical Electrodynamics* (Wiley, New York, 1975), 2nd ed., p. 186, Eq. (5.71).

[8]See, for example, Ref. 4, p. 98, or Ref. 6, p. 120 (SI units!).

[9]See, for example, Ref. 6, p. 102.

[10]Reference 7, p. 182, Eq. (5.56).

[11]Reference 7, p. 185, Eq. (5.69).

[12]Since $\mathbf{F} = -q_m\mathbf{B} + q_m[\mathbf{B} + (d\mathbf{r}\cdot\nabla)\mathbf{B}]$.

[13]Reference 7, p. 239, Eqs. (6.121) and (6.122).

LETTER TO THE EDITOR
submitted to American J. Physics

RELATIVITY AND ELECTROMAGNETISM
(MARINOV'S COMMENTS ON THE PAPER OF W. RINDLER)

In a paper under the same title Rindler[1] asserts that if a magnet moves with a velocity **v**, then,at a point where the magnetic potential generated by the magnet is **A** and where a unit electric charge rests, the following force will act on the charge (in the SI-system of units)

$$\mathbf{E}_1 = (\mathbf{v}.\mathrm{grad})\mathbf{A}. \tag{1}$$

Meanwhile, if the charge moves with a velocity **v** and the magnet is at rest, the acting force, as commonly known, will be

$$\mathbf{E}_2 = \mathbf{v}\times\mathrm{rot}\mathbf{A}. \tag{2}$$

According to the principle of relativity, the force acting in the first case must be not (1) but $\mathbf{E}_{relativistic} = -\ \mathbf{v}\times\mathrm{rot}\mathbf{A}$ and since 70 years this is taught in schools and universities, as if formula (1) is the right one, then the principle of relativity will be violated.

In the last 20 years I have submitted about 100 papers to the AM. J. PHYS. all of which have been rejected as they were in contradiction with the theory of relativity. Many papers have been submitted where I showed that formula (1) is the right one and not the above relativistic formula. And now I see in the AM. J. PHYSICS *my* formula. However Prof. Rindler has not noticed that this formula was already deduced by me,besides in many of my books, also in two authoritative journals[2,3].

If a magnet and a unit electric charge move with the same velocity **v** in absolute space, according to the theory of relativity, there is no force acting on the charge, but according to my theory the acting force is[4]

$$\mathbf{E}_3 = (\mathbf{v}.\mathrm{grad})\mathbf{A} + \mathbf{v}\times\mathrm{rot}\mathbf{A}. \tag{3}$$

In 1917 Kennard[5] first showed experimentally the validity of formulas (1), (2) and (3). Kennard's experiment was rotational. Making an inertial variation of Kennard's experiment, I succeeded for a fourth time to measure the Earth's absolute velocity[4] (the other three times my measurements of the Earth's absolute velocity were optical[6,7,8]) but I cannot find a scientific vehicle to publish the report on my childishly simple experiment.

I must add that Prof. Rindler's formula (1) and all what he writes about the magnetic monopoles is a pure nonsense. Proceeding from the wrong principle of relativity, Prof. Rindler asserts that on a magnetic charge q_m,moving with a velocity **v** in an electric field **E** generated by electric charges at rest, the following force will act

$$\mathbf{F} = -\ q_m\mathbf{v}\times\mathbf{E}, \tag{4}$$

because if the magnetic charge is at rest and the electric charges are moving with the velocity **v**, there will be a force

$$\mathbf{F} = q_m \mathrm{rot}(\mathbf{v}\Phi) = q_m \mathrm{rot}\mathbf{A} = q_m \mathbf{B} \tag{5}$$

acting on the magnetic charge where Φ is the electric potential of the charges, **A** their magnetic potential, and **B** their magnetic intensity.

Prof. Rindler can charge the circumference of a disk by electric charges. If the disk will be set in rotation, there will be a torque on a magnetic needle placed in the neighbourhood of the disk because of the flowing convection current. However if the charged disk will be at rest and Prof. Rindler will rotate the needle around the disk, he will see that there is no torque. An inertial variation of this experiment can be made by charging a long band.

I think that it is time that Prof. Rindler or another relativist with authority recognizes in the press the bancrupcy of relativity and that the AM. J. PHYS. stops with the publication of nonsensical relativistic papers which since so many years polute the minds of the students and of the college professors all over the world. If in six months after the publication of my letter no relativist will comment on it, the students and the college professors have to conclude that relativity is dead.

REFERENCES

1. W. Rindler, Am. J. Phys. **57**, 393 (1989).
2. S. Marinov, Nature **322**, p. x (21 August 1986).
3. S. Marinov, New Scientist **112**, 48 (1986).
4. S. Marinov, *The Thorny Way of Truth*, Part IV (East-West, Graz, 1989).
5. E. H. Kennard, Philosoph. Mag. **33**, 179 (1917).
6. S. Marinov, Czech. J. Phys. **B24**, 965 (1974).
7. S. Marinov, Gen. Rel. Grav. **12**, 57 (1980).
8. S. Marinov, *The Thorny Way of Truth*, Part II (East-West, Graz, 1986).

Marinov's note. The above letter to the editor was sent to Prof. R. Romer, the editor of AM. J. PHYS., on the 20 December 1989. I affirm that it is more easy for the waters of Mississippi to begin to flow from the ocean to the mountain than for Dr. Romer to publish my letter. Oh, Albert, bleicher Vater, wie haben dich deine Söhne zugerichtet, daß du unter den Weisen sitzest ein Gespött oder eine Furcht!

IMPORTANT MARINOV'S COMMENTS
TO THE PRECEDING MARINOV'S COMMENTS

Prof. Rindler asserts (and I share Rindler's opinion) that if a magnet moves with a velocity **v**, then, at a point where the magnetic potential generated by the magnet is **A** and where a unit electric charge rests, the following force will act on the charge

$$E = (\mathbf{v}.\text{grad})\mathbf{A}.$$

According to the principle of relativity, however, this force must be

$$E_{relativistic} = - \mathbf{v}\times\text{rot}\mathbf{A}.$$

Here is the excerpt of a referee's opinion on my paper published in TWT-IV, p. 101, sent to me from Canada on the 26 June 1989 where this idiotic relativistic assertion is "deduced":

> I have read the papers by Stefan Marinov that you sent me to review, and I also asked * , a high energy theorist in * , to look at them. None of the papers are suitable for publication in a respectable physics journal.
>
> Marinov supposes that there is some absolute frame in which the equations of electromagnetism have a special form. This is not supported by any evidence and is in disagreement with the conventional view.
>
> * points out that, for example, Eq. 9 on Page 5 of the paper "Absolute and Relative Newton-Lorentz Equations" should be
>
> $$\vec{E} = -\vec{\nabla}\phi - \frac{\partial A}{\partial t}$$
>
> $$\vec{E} = -\vec{\nabla}(\vec{V}\cdot\vec{A}) + (\vec{V}\cdot\vec{\nabla})\vec{A} \quad .$$
>
> The first term, which is dropped by Marinov, comes from the retardation of the vector potential
>
> $$\vec{E} = -\vec{V}\times(\vec{\nabla}\times\vec{A})$$
>
> using $\vec{V}\times(\vec{\nabla}\times\vec{A}) + (\vec{V}\cdot\vec{\nabla})\vec{A} = \nabla(\vec{V}\cdot\vec{A})$ for $\vec{V}$ a constant
>
> $$\therefore \quad \vec{E} = -\vec{V}\times\vec{B} \quad .$$
>
> This is the conventional result for the $\vec{E}$ field that results from the Lorentz transformation of a $\vec{B}$ field.
>
> *The name is deleted not by me. - S. Marinov

I do not reveal the name of the editor who sent me this referee's opinion, as this editor is a very nice and correct person. If only two or three editors in the world will be as democratic and correct as this editor from Canada, the scientific truth will in a couple of months break the wall of scholastic dogmas and obvious stupidities which entrangle today's physics.

Now I wish to show mathematically that when there is an infinitely long (or very long) band covered with electric charges and a magnet in its neighbourhood (let us consider a solenoid feeded by constant current), then, in the case that the band will be moved with the relative velocity $\mathbf{v}$ in the laboratory, there will be a torque acting on the magnet at rest, however, in the case that the band is at rest and the magnet will be moved with the same velocity $\mathbf{v}$, there will be no torque.

Let us suppose that the absolute velocity of the laboratory is $\mathbf{V}$ and let us consider some electric charge q moving with the laboratory velocity $\mathbf{v}_m$ in some wire element of the magnet (as I showed - see TWT-II, p. 100 - v_m is of the order of c). Denoting by Φ and $\mathbf{A}$ the laboratory electric and magnetic potentials generated by the electric charges fixed to the very long band at the point of location of the charge q, we shall have for the potential force acting on this charge q, according to the relative Newton-Lorentz equation written in the CGS-system of units (see TWT-IV, p. 103), for the case when band and magnet are at rest in the laboratory,

$$\mathbf{F} = - q\mathrm{grad}\Phi + q(\mathbf{v}_m.\mathbf{V}/c^2)\mathrm{grad}\Phi. \qquad (1)$$

For the case when the magnet will be moved with the relative velocoty $\mathbf{v}$ in the laboratory, the acting force will be

$$\mathbf{F}' = - q\mathrm{grad}\Phi + q\{(\mathbf{v}_m + \mathbf{v}).\mathbf{V}/c^2\}\mathrm{grad}\Phi = \mathbf{F} + q(\mathbf{v}.\mathbf{V}/c^2)\mathrm{grad}\Phi. \qquad (2)$$

As $v \ll c$, the additionally acting force

$$\mathbf{F}' - \mathbf{F} = q(\mathbf{v}.\mathbf{V}/c^2)\mathrm{grad}\phi \qquad (3)$$

is extremely small with respect to the initial force $\mathbf{F}$ and surely there will be no experimental possibilities to register it, so that we can write

$$\mathbf{F}' \cong \mathbf{F}. \qquad (4)$$

For the case when the band will be moved with the velocoty $\mathbf{v}$ in the laboratory, the force acting on the charge q of the magnet at rest will be, taking into account that now the laboratory magnetic potential will be $\mathbf{A} = \Phi\mathbf{v}/c$ and using in the last two terms of (5) the formulas for rotation and vector-gradient of double products (see my CLASSICAL PHYSICS, vol. I, p. 212),

$$\mathbf{F}'' = - q\mathrm{grad}\Phi + q(\mathbf{v}_m.\mathbf{V}/c^2)\mathrm{grad}\Phi + (q/c)\mathbf{v}_m\times\mathrm{rot}\mathbf{A} + (q/c)\mathbf{V}\times\mathrm{rot}\mathbf{A} + (q/c)(\mathbf{V}.\mathrm{grad})\mathbf{A} =$$

$$- q\mathrm{grad}\Phi + q(\mathbf{v}_m.\mathbf{V}/c^2)\mathrm{grad}\Phi + (q/c)\mathbf{v}_m\times\mathrm{rot}\mathbf{A} + q(\mathbf{v}.\mathbf{V}/c^2)\mathrm{grad}\Phi =$$

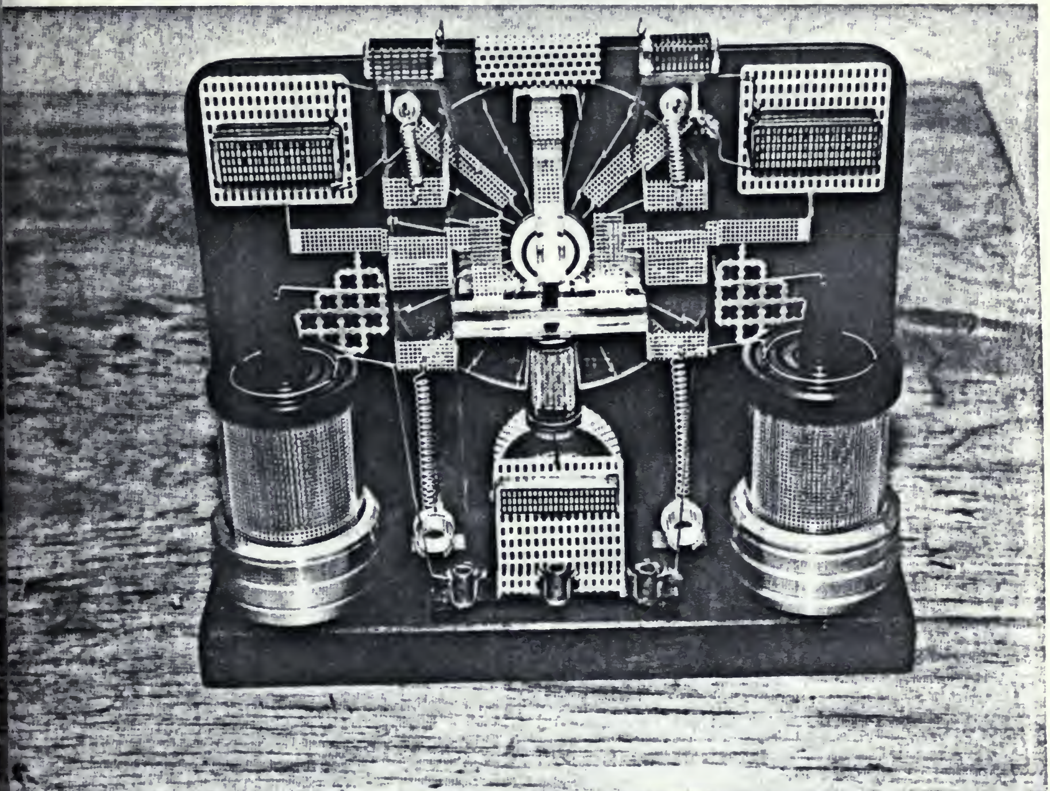
$$\mathbf{F} + (q/c)\mathbf{v}_m\times\mathrm{rot}\mathbf{A} + q(\mathbf{v}.\mathbf{V}/c^2)\mathrm{grad}\Phi. \qquad (5)$$

Now, taking into account that $v \ll c$, we shall obtain for the additionally acting force

$$\mathbf{F}'' - \mathbf{F} \cong (q/c)\mathbf{v}_m\times\mathrm{rot}\mathbf{A} = I d\mathbf{r}\times\mathbf{B}/c, \qquad (6)$$

where $\mathbf{B}$ is the magnetic intensity generated by the charges on the band and $Id\mathbf{r} = q\mathbf{v}_m$ is the current element of the magnet where the space current is $q\mathbf{v}_m$. This force is considerab and there will be a torque acting on the magnet.

FRIGIDAIRE, Roma, Italy, Nr. 108, November 1989



oto rarissima a colori della macchina Testatika, un apparecchio costruito dalla comunità Methernita in Svizzera oltre leci anni fa e che produce energia "dal niente". Ne parla diffusamente Stefan Marinov in questo numero.

CONTENUTI

Stefan Marinov

Sullo stato presente della Fisica

(quasi una intervista con paolo brunetti e antonio papa)

La scienza naturale più esatta, la Fisica, si trova in una crisi talmente profonda che non si può non chiedersi: "Ma la Fisica è davvero una scienza esatta?".

Da quasi un secolo, infatti, la Fisica Ufficiale afferma:

1) Spazio assoluto (etere) e tempo assoluto non esistono.

2) La velocità di un laboratorio soggetto a movimento inerziale non può essere misurata.

3) Gli effetti che si osservano dipendono solo dalle velocità relative dei corpi che interagiscono in un sistema isolato (principio della Relatività).

4) Una accelerazione cinematica non può essere distinta da una accelerazione gravitazionale (principio dell'equivalenza).

5) L'atomo è rappresentabile come un sistema planetario - ipotesi di Bohr - e non con un sistema rigido, come ipotizzava J.J. Thomson e, attualmente, ipotizza Roberto Monti.

6) Il Sole è più caldo dentro che fuori, e solo le alte temperature e la forte densità possono trasformare l'idrogeno in elio (al contrario di quanto ipotizzava Herschel e di quanto, da alcuni anni, ipotizza Renzo Boscoli con i suoi modelli di Sole "freddo" e le sue teorie di fusione nucleare "criogenica").

7) Anche se un giorno dovessero cambiare tutte le leggi della Fisica, le leggi di conservazione dell'energia, del momento e del momento angolare rimarranno sempre immutate e valide.

- Ma tutti questi "pilastri" della Fisica Ufficiale stanno ormai crollando. Cosa resta dunque? Su quale base assiomatica possiamo costruire la Fisica di domani? -

E' questo l'interrogativo posto a Stefan che ha fatto scaturire una chiacchierata post prandiale (raccolta da un registratore forse meno amichevole ma certamente più sobrio di noi) che riportiamo qui, senza alcun intervento sull'italiano di Stefan per non togliere il gusto "dal vivo" di questa intervista.

Stefan - Guardiamo concretamente ognuno di questi piloni. Vediamo che per la maggioranza di loro non si fa una fisica nuova, ma si buttano via concetti e teorie illogici e falsi e si torna ai concetti sani, semplici e chiari che erano già introdotti dai grandi spiriti del passato, come Galileo, Newton, Gauss. Dunque dobbiamo sostituire qualche pilone fatto nel ventesimo secolo con del legno marcio con i piloni di marmo già eretti dai giganti del pensiero umano.

Prendiamo lo spazio assoluto e il tempo assoluto. Le chiamiamo spazio e tempo newtoniani. Ma ogni bambino, guardando il mondo attorno a lui, arriva a questi concetti da solo. Poi vengono Einstein e Minkowski e ti fanno un'insalata spazio-temporale che per masticarla devi romperti i denti. -

- Questo ricorda l'aneddoto su Eddington... -

Stefan - Il quale? Ci sono tanti! -

- Quello che narra come Eddington, di fronte all'affermazione che solo altre due persone, oltre Einstein, capivano la Teoria della Relatività, rimase assorto a capo chino e, richiesto di cosa stesse riflettendo, rispose che si domandava chi potesse essere ... l'altra! -

Stefan - Bravo, hai colpito la testa del chiodino! Dunque siamo in corsa di buttar via questo, che tre (o solo due) uomini pensavano di aver capito e che tutta l'ammucchiata dei fisici accettava come rivelazione divina, gridando "sì, sì, è così, è vero", mentre non capivano un acca nella cacca einsteiniana.

Ecco tutta la storia con i primi quattro piloni. Si buttano via perchè gli esperimenti hanno mostrato che questi piloni sono falsi e i profeti che li hanno portato erano falsi profeti.

Il quinto pilone: il modello dell'atomo. Ma chi sarebbe capace a dirti quale è il modello?! E' assurdo di pensare che l'atomo può essere osservato. Osserviamo certi effetti e facciamo ipotesi sul modello. Questo di Bohr ha spiegato qualcosa, ma è tanto artificiale e illogico. E quando vuoi fare il modello degli atomi con più protoni e neutroni o i modelli delle molecule, questo di Bohr non ti aiuta un cazzo. Adesso l'amico Monti promette di spiegare gli effetti che osserviamo con il modello rigido. Aspettiamo. Se riuscirebbe, questo sarà un passo storico di enorme importanza nelle tenebre della materia.

Il relativismo è finito. E come l'ho dimostrato con i miei esperimenti e libri, mettere il dito nel culo della relatività era una cosa per bambini. Ma questo che sarà in grado di metter il dito nel culo della fisica quantistica, dovrebbe avere una mano lunghissima. Ho paura

Qualcuno domandò ad Einstein: "Professore, potrebbe dire in poche parole qual'è la sostanza della sua Teoria della Relatività?"

"Certo" rispose Einstein "Se lei mette il suo naso nel mio culo, io ho un naso in culo, lei ha un naso in culo, ma la posizione preferibile è quella dal mio punto di vista".

che i problemi là sono troppo complicati per essere risolti in un breve tempo, e forse non saranno mai risolti con una teoria semplice e chiara.... -

- E chi lo sa?! Per lunghi secoli il movimento dei pianeti rimase coperto dal mistero o spiegato da falsi profeti come Tolomeo. Ma un giorno Dio, o chi per lui, disse "la luce sia!", e nacque Newton.-

- E se Dio non l'avesse detto? Saremmo rimasti al buio?

- Beh, crederemmo ancora alle fantasie di falsi profeti che, oggi, avrebbero qualche cattedra nelle nostre università, o qualche superdirezione in qualche megalaboratorio, magari in Svizzera!... -

- Come si dice?... "Ogni riferimento a persone viventi eccetera eccetera è puramente casuale..." -

- Cosa ci dici ora, Stefan, sul sesto pilastro? -

Stefan - Siamo in corso di stabilire se veramente il sole dentro è freddo e se la fusione fredda davvero lavora e potrebbe essere industrialmente utilizzata. E' un problema piuttosto tecnologico. Come è la superconduttività alle temperature alte: si prende questo, si prende l'altro, si mischia e si sta a guardare. Se riesci come sono riusciti Bednorz e Müller, la via per Stoccolma è aperta.

La fusione fredda anche è un po' come la preparazione del cibo nella cucina: uno prende il palladio, l'altro non trova palladio, prende titanio, come la cuoca prende l'aglio quando non trova cipolla. Uno cuoce la zuppa non cambiando temperatura, l'altro l'abbassa, mentre le cuoche le zuppe le riscaldano e le fanno bollire. Altre differenze quasi non ci sono. -

- Resta il settimo e ultimo "pilone", come lo chiami tu... -

Stefan - Questo davvero è un pilone pilonissimo. Nella sua sostanza tutte le nostre formule fisiche sono basate sulle leggi della conservazione dell'energia, del momento e del momento angolare. La scienza di oggi si immagina ogni fenomeno o processo fisico come trasformazione dell'energia d'una forma in un'altra forma. Se scrivi qualcosa contro Einstein o contro Maxwell, se pure con tanta difficoltà ma troverai un giornaletto per pubblicare l'articolo. Ma se scrivi qualcosa contro le leggi della conservazione o se solo pronunci le parole "perpetuum mobile" ti prendono per pazzo.-

- Ma il tuo articolo "Violazione delle leggi di conservazione di momento, mo-

Un giorno Einstein raccolse dei prataioli nel Boschetto del Paradiso e li portò a Newton per preparare un pasticcio con funghi per la cena.

"Ma io non so come farlo" disse Newton.

"Mein Gott, Isaac, sulla terra non v'è nulla di più semplice che combinare un pasticcio!"

mento angolare e energia" è stato pubblicato... -

Stefan - Già! Dal vostro *SEAGREEN*, ma è l'unico al mondo. Sapete che il mio articolo "Experimental violations of the principles of relativity, equivalence, and conservation of energy and angular moment"* è accettato da tre anni da NATURE. Nel terzo volume del mio THE THORNY WAY OF TRUTH è fotocopiato il testo di questo articolo che dottor Maddox, l'editore di NATURE, ed io abbiamo composto insieme nel suo ufficio a Londra; sulle stesse pagine del libro ho pubblicato una dozzina di lettere con le quale dottor Maddox aggiorna la pubblicazione del articolo... e da tre anni l'articolo non esce! -

- Ma di cosa ha paura questo dottor Maddox? Perchè non vuol pubblicare la descrizione e i risultati degli esperimenti? -

Stefan - Perché le leggi della conservazione sono il "sancta sanctorum" della fisica odierna. I fisici sono forse in grado di inghiottire il crollo dei principi della relatività, dell'equivalenza; inghiottiranno l'atomo rigido, il sole freddo e forse domani andranno a pisciare sul dualismo onda-particella... -

- Abbiamo visto il "giro a 180°" che hanno fatto Zichichi e Rubbia sulla fusione fredda!... -

Stefan - Ma la violazione delle leggi di conservazione non sono in grado di inghiottirle!

- .. i russi sono pronti a togliere dal mausoleo la salma di Lenin...

Stefan - Le leggi della conservazione pesano sulla comunità scientifica con un peso molto più grave che il pensiero di Lenin sulle teste dei comunisti. Portar via la salma di Lenin si considera come un sacrilegio, mentre accettare che le leggi di conservazione possono essere violate è per ogni fisico di oggi un harakiri! -

- E per te cos'è? -

Stefan - Per me queste violazioni sono semplici fatti sperimentali che devono essere spiegati. Non vedo nessuno stravolgimento. Ho sempre detto che in ogni elettromotore che l'umanità conosce c'è solo una uguaglianza numerica fra l'energia "persa" dalla sorgente elettrica e l'energia meccanica "acquistata" dal rotore o "dissipata" come calore a causa dell'attrito. E' quasi la stessa cosa come quando cambi in una banca lire italiane e scillinghi austriaci. Si cambiano uno per cento. Quando cambi scillinghi per lire fai "dissipazione", come è la dissipazione dell'energia elettrica o meccanica in energia termica, perché è abbastanza difficile di fare il ricambio (l'ho già sperimentato nelle banche italiane). Ma con alcune difficoltà ricevi anche scillinghi per lire italiane. Ogni cambiamento si fa con certe perdite. Comunque ottenere per uno scillingo più di cento lire o viceversa è impossibile. -

- A meno di non trovare qualche espediente! -

Stefan - Esattamente! Una tale furbizia ha trovato l'orologiaio Paul Baumann della comunità religiosa Methernita nel villaggio Linden vicino Berna. Lui ha costruito una machina (l'ha chiamata TESTATIKA) che "trasforma" energia meccanica in energia elettrica, ma di più di cento per cento. Dunque una parte dell'energia elettrica mantiene la rotazione meccanica e una parte diventa "energia libera" che puoi usufruire. E' un moto perpetuo classico. -

- Ma tu l'hai vista coi tuoi occhi? -

Stefan - L'ho vista e mi sono anche fatto fotografare davanti a due di quelle machinette -

- E... girano? -

Stefan - Girano, girano!... -

- Eternamente?... -

Stefan - Eternamente! -

- Beh, io faccio fatica a crederci!... -

Stefan - Che tu credi o non credi, questo non cambia niente nell'esistenza della macchina. Perché la macchina gira non secondo il tuo pensiero e la tua fede, o secondo il pensiero e la fede di tutti i fisici del mondo, ma secondo le leggi del Dio. E Dio dice che energia si può produrre da niente e anche energia si può trasformare in niente. Guarda la mia macchina Bul-Cub senza statore. E' una macchina che ha solo rotore. I fisici dicono che una tale macchina non può essere messa in moto, come non puoi mettere in moto una barca se tutti i motori sono chiusi nella sua cabina. Mentre io la macchina Bul-Cub senza statore l'ho messa in rotazione: dunque trasformo niente in momento angolare.

E la cosa più comica è che la legge di questo comportamento della macchina Bul-Cub senza statore si spiega con la così detta equazione di Lorentz, che puoi trovare in ogni libro d'elettromagnetismo. E devi notare che nel uno di dieci libri di elettromagnetismo c'è scritto che l'equazione di Lorentz viola la terza legge di Newton.

- Quella che dice che ad ogni azione corrisponde una reazione uguale e contraria?... -

Stefan - Esattamente! -

- Allora la terza legge di Newton non vale nell'elettromagnetismo! -

Stefan - Ma ogni bambino arriva a questa conclusione guardando l'equazione di Lorentz che è la formula fondamentale dell'elettromagnetismo. Ogni bambino! E se fino adesso nessuno ha dimostrato la violazione della terza leg-

*momentum

ge di Newton è perché tutte le macchine elettromagnetiche sono fatte con circuiti chiusi. Ogni bambino che conosce un po' la matematica arriva alla conclusione che per circuiti chiusi la terza legge di Newton rimane valida. Ma anche ogni bambino può dimostrare che per circuiti non chiusi la terza legge può essere violata. -

- E nessuno ha fatto esperimenti con circuiti non chiusi? -

Stefan - Solamente due persone: Graham e Lahoz nel 1980 (pubblicazione in NATURE), ma non hanno capito l'importanza del loro esperimento e l'hanno interpretato male. E poi io.

- Violazione della legge della conservazione del momento angolare... questo mi sembra un concetto un po' complicato per un tizio qualunque. Ma una macchina che gira da sola, questo non ha bisogno di spiegazioni: se la vede è chiaro anche per un'idiota... -

Stefan - Anche per due o per tre! -

- E come mai questa macchina TESTATIKA rimane sconosciuta? Perchè nessuno ne parla, ne scrive? -

Stefan - Io sto parlando, e scrivendo. Sto perfino gridando! Ma i Zichichi e i Rubbia non vogliono nemmeno ascoltare. Vi racconto questo. Marzo 1979. Centesimo anniversario di Einstein. Conferenza solenne a Berna. Zichichi presidente della giornata. Prendo la parola e dico ad alta voce: "La relatività è morta. Ho misurato la velocità della luce in una direzione e ho stabilito con quali chilometri in secondo e in quale direzione nel cosmo la nostra terra sta muovendo". Zichichi sorride dal palcoscenico. E io gli dico: "Caro Zichichi, non mi sorrida nella faccia, ma venga a vedere l'esperimento" -

- E' venuto? -

Stefan - L'aspetto da dieci anni! -

BIOGRAFIA

Stefan Marinov nasce a Sofia, nel 1931, in una famiglia di intellettuali comunisti.

Nel 1948 termina il Liceo Sovietico a

Lorsqu'un homme sage comprend qu'il ne peut comprendre la théorie d'Einstein, mais pour que personne de ces homme sages, qui comprennent qu'ils ne peuvent la comprendre et font semblent de la comprendre, ne comprenne qu'il comprend qu'il ne peut la comprendre, cet homme sage comprend, qu'il doit faire semblent de la comprendre, et alors tous ces hommes sages, qui ont compris qu'ils ne la comprenaient pas, mais faisaient semblent de la comprendre, ne comprendront pas, qu'il a compris qu'il ne la comprenait pas.

Praga ed inizia i suoi studi di Fisica all'Università di Praga prima e Sofia, poi. Nel 1951 entra volontario nella Scuola Marittima Militare a Varna e, conseguitone il diploma, naviga come ufficiale su piroscafi mercantili bulgari, cecoslovacco-cinesi e tedeschi.

Nel 1958 torna a Sofia per riprendere gli studi di fisica e laurearsi.

Negli anni 1960-1974 lavora nell'Istituto di Fisica dell'Accademia delle Scienze Bulgara, a Sofia, da dove, per il suo dissenso politico, viene licenziato come "paranoico".

Negli anni 1974-1977 dirige il proprio "Laboratorio per Problemi Fisici Fondamentali".

Negli anni '66, '67, '74 e '77 è sottoposto forzatamente a cura in ospedali psichiatrici di Sofia. Ricevuto il passaporto, nel 1977, parte per Bruxelles.

Nel '78 vive a Washington, dal '79 all'82 a Genova e dall'82 a tutt'oggi a Graz, dove dirige il suo "Istituto di Fisica Fondamentale".

Privato della cittadinanza bulgara nell'81 (assieme alla confisca della propria casa), Stefan Marinov si dichiara oggi cittadino del mondo e membro del governo mondiale.

Oltre ad una cinquantina di lavori scientifici (quasi tutti nell'ambito della fisica dello spazio-tempo) pubblicati su giornali europei, americani e indiani, Marinov ha pubblicato i seguenti libri:

EPPUR SI MUOVE, axiomatics, fundamentals and experimental verifications of the absolute space-time theory (Bruxelles, 1977).

LIST OBTRULEN, raccolta di poesie scritte in bulgaro, russo, ceco, tedesco, polacco (Washington D.C, 1978)

ECONOMIA POLITICA TEORICA, teoria dei prezzi (Genova, 1979).

CLASSICAL PHYSICS, enciclopaedia on theoretical physics - five volumes (Graz, 1981).

PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON SPACE-TIME ABSOLUTENESS, Genova, July 1982 (Graz, 1982).

VADE RETRO, SATANAS, libro satirico in bulgaro e russo (Graz, 1982).

CALVARIO, sonetti in italiano che introducono le dodici tele del grande pittore tosco-ligure Renato Cenni (Genova, 1982).

THE THORNY WAY OF TRUTH, documents on the restoration of the absolute space-time conceptions and the violation of laws of conservation - five volumes (Graz, 1982-1989).

Marinov ha misurato per la prima volta (1973) la velocità assoluta della terra (misurazioni ripetute poi con diverse altre apparecchiature a Sofia, Bruxelles e Graz) **ed ha dimostrato la non validità del principio della relatività.**

Per primo ha poi dimostrato sperimentalmente la non validità del principio di equivalenza.

Nel 1984 ha scoperto l'induzione mozionale-trasformatoria ed ha stabilito sperimentalmente che gli effetti nell'elettromagnetismo dipendono dalle velocità assolute dei corpi e devono essere calcolati con i potenziali e non con le intensità, dimostrando altresì, sempre sperimentalmente, che la "gauge invariance" può portare ai risultati sbagliati.

Per primo (1988) ha dimostrato sperimentalmente che la corrente di spostamento non produce campo magnetico e non reagisce (già dimostrato nell'87) con forze pondero-motrici all'azione di altri campi magnetici (l'elettromagnetismo di Maxwell sostiene le tesi opposte).

Ancora un primato: nel 1987 ha osservato la violazione della legge di con servazione del momento angolare con la sua macchina Bul-Cub senza statore e con il suo ponte di Ampère ruotante con corrente di spostamento (nell'esperimento di Graham e Lahoz non tutto il sistema era sospeso liberamente e quindi non poteva offrire una dimostrazione inconfutabile di questa violazione).

Nel 1985 (primo, ancora una volta) dimostra (e spiega) che l'elettromotore con cuscinetti a sfera è una macchina termica e non elettromagnetica, stabilendo sperimentalmente che tale macchina viola la legge di conservazione dell'energia (mentre ogni ingegnere elettronico o fisico direbbe che tale elettromotore a cuscinetti non dovrebbe nemmeno ruotare).

Marinov ha osservato violazione della legge di conservazione dell'energia nel disco di Faraday sperimentando con il disco pieno di mercurio (Bruce de Palma per primo annunciò tale violazione nel 1980, nel caso di un disco solido per il quale le misurazioni di Marinov hanno portato a risultati non irrefutabili).

Marinov ha osservato violazione della legge di conservazione dell'energia anche nella sua macchina MAMIN COLIU (MArinov's Motional-transformer INductor COupled with a LIghtly rotating Unit).

Energia che viene dal niente
LA MACCHINA TESTATIKA

di stefan marinov

Il quinto volume della mia collana scientifica *THE THORNY WAY OF TRUTH* è dedicato quasi completamente alla macchina TESTATIKA.

Ho presentato tale macchina anche in un lungo articolo del giornale tedesco di scienza alternativa *RAUM UND ZEIT* (numero 40 di quest'anno).

Personalmente non ho smontato la macchina e non ne possiedo disegni tecnici. I disegni che sono pubblicati nel mio libro sono stati eseguiti da persone che hanno esaminato la macchina (Albert Hauser, Danimarca) o che l'hanno vista solamente in fotografia (Don Kelly, Florida). Credo, però, che neppure nella Comunità Methernitha, dove negli ultimi dieci anni - sotto la guida di Paul Baumann - sono state realizzate diverse macchine TESTATIKA, esistano disegni tecnici dettagliati.

Le fotografie - di ottima qualità - che presento nelle mie pubblicazioni (come quella sulla copertina di FRIGIDAIRE) mi sono state date dalla Comunità Methernitha, con la quale sono strettamente legato, e sono di sua proprietà.

In sostanza, devo dire che non sono a conoscenza di tutto il "segreto" della macchina e per questo non so se, anche disponendo di un laboratorio ben attrezzato, sarei capace di riprodurla.

E' ovvio, dunque, che il lettore non sarebbe in grado di ricostruire la macchina dopo la lettura delle mie pubblicazioni (e dovrebbe... continuare a pagare la bolletta dell'ENEL!). Però, se approfondisse il mio libro, sarebbe in grado di capirne il fondamento fisico di cui dò qui una breve sintesi.

L'inventore della macchina, Paul Baumann, è arrivato alla sua scoperta - in grado di rivoluzionare in pochi anni la vita sull'intero pianeta - seguendo non già la *logica scientifica*, ma una via intuitiva per la quale l'ispirazione è stata il fattore determinante. Ciò nonostante, la sua macchina rappresenta, nei principi, una ripetizione di macchine già note. La prima macchina con moto perpetuo che Baumann costruì, in una prigione svizzera, nella seconda metà degli anni settanta, rappresenta quasi una replica dell'elettromotore perpetuo del Padre Giuseppe Zamboni; una variante di tale elettromotore da 140 anni si muove nel Clarendon Laboratory dell'Università di Oxford, senza che, in questi 140 anni, alcuna sorgente energetica abbia fornito energia per il mantenimento del suo movimento.

La prima macchina di Bauman era costituita, essenzialmente, da una leva metallica attirata da un elettrodo positivo che, nel contatto la caricava di elettricità positiva. Le forze di Coulomb respingevano la leva, e la sua estremità opposta contattava un elettrodo negativo che la caricava negativamente; in tal modo la leva era di nuovo attirata dall'elettrodo positivo ricominciando il ciclo.

La differenza fra l'elettromotore perpetuo di Zamboni e la prima macchina di Baumann consisteva nel fatto che, mentre nel primo gli elettrodi sono collegati a due poli di una pila a secco che fornisce una tensione di 3 - 4 mila volt, nella seconda i due elettrodi erano collegati ai poli di un condensatore che si carica ad una tensione iniziale mediante un movimento della mano.

Dunque l'elettromotore perpetuo di Zamboni ricarica la sua pila che fornisce la forza propulsiva, mentre l'elettromotore perpetuo di Baumann ricarica il condensatore che fornisce la forza propulsiva. La fisica attuale nega che ciò possa avvenire, in quanto verrebbe contraddetta la cosiddetta "legge di conservazione dell'energia".

Ma Baumann, che non ha letto libri di fisica, l'ha realizzata e, nella fisica, vale non ciò che sta scritto nei libri, ma ciò che gli esperimenti dimostrano. Io non ho visto questa prima macchina, e

Marinov con le due prime macchi
ne TESTATIKA a un disco (le macchi
ne TESTATIKA più potenti hann
due dischi contro-rotanti come nel ge
neratore di Wimshurst). Paul Bau
mann ha costruito le due macchine qu
raffigurate nel 1978, in una prigion
svizzera, dove, con una accusa falsifi
cata, scontava sette anni di galera
(Noi, ingenui, pensiamo che solo i
Russia si finisca in galera innocenti!
E' interessante notare che il perpe
tuum mobile di Baumann inizialmen
te era realizzato non con un disco ro
tante ma con una leva, basato sull
stesso principio dell'elettromotor
perpetuo dello scienziato veronese G
Zamboni, del secolo scorso, e descritt
dallo stesso Zamboni nel suo libro in
titolato appunto *"Sull'elettromotor
perpetuo"* (stampato nel 1843 dalla Ti
pografia G.Antonelli di Verona e ri
prodotto nel sesto volume *"Th
Thorny Way of Truth"* di Marinov). U
orologio costruito secondo tale princi
pio di Zamboni è in funzione da 14
anni nel laboratorio Clarendon del
l'Università di Oxford, ma i... *"rino
ceronti"* aspettano che si fermi da u
minuto all'altro!

riferisco quanto mi ha detto Baumann stesso. Nell'anno 1978, nella prigione svizzera in cui scontava una condanna - seguita ad una falsa accusa - di sette anni, Baumann realizzò le due macchine con le quali sono fotografato.

Queste sono macchine TESTATIKA con un disco rotante. Le macchine da lui costruite negli ultimi anni, una volta uscito di prigione, sono a due dischi contro-rotanti. Il diametro dei primi dischi è di una ventina di centimetri, e quello delle macchine a due dischi è di 50 centimetri. Attualmente sono in costruzione macchine con dischi di 100 e 200 centimetri.

In sostanza, la macchina TESTATIKA rappresenta un cosiddetto "generatore di influenza".

I primi generatori di influenza sono stati costruiti da Töpler, a Riga, e da Holtz, a Berlino, negli anni sessanta del secolo scorso. Il generatore di influenza più conosciuto è quello di Whimshurst; ed è a questo che, in effetti, assomigliano le TESTATIKA a due dischi controrotanti.

Nel V volume del mio *THE THORNY WAY OF TRUTH (TWT-V)*, ho riprodotto gli articoli più importanti del secolo passato (quasi tutti pubblicati negli *ANNALEN DER PHYSIK* di Poggendorf) dedicati ai generatori di influenza oltre al brano che l'enciclopedia Treccani dedica all'argomento.

Le macchine di influenza possono essere non solo generatori, ma anche motori. L'effetto motore è stato osservato per la prima volta da Holtz, nel suo generatore di influenza, anche se dobbiamo notare che il primo motore elettrostatico era stato costruito da Franklin già nel XVIII secolo.

Poggendorf fu invece il primo ad osservare che un motore elettrostatico, che ottiene la sua propulsione da un condensatore inizialmente caricato ad alta tensione (dell'ordine di parecchie migliaia di volt), ricarica il suo condensatore durante la rotazione. Poggendorf (v. TWT-V) osserva che durante i due anni in cui ha sperimentato il suo motore elettrostatico non è stato in grado di capire gli effetti strani che compaiono. Questa sperimentazione d
Poggendorf non è più stata ripetuta.

Io credo che Baumann sia il second
scienziato che non solo abbia capito ch
un motore elettrostatico può ricarican
il suo condensatore, ma che abbia anch
realizzato questa ricarica con un cicl
chiuso, trasformando il millenario so
gno del moto perpetuo in una realtà, an
che se, debbo ripetere, io non ho com
preso esattamente come questa ricaric
avvenga.

Ma la macchina TESTATIKA non solo mantiene il suo movimento da sola, essa produce anche energia libera in abbondanza.

Le macchine con cui sono fotografa
to (una delle quali è anche in copertina)
producono alcune centinaia di watt d
energia libera. Quelle a due dischi pro
ducono quasi 3 kilowatt di energia libe
ra in forma di corrente continua - di un
decina di ampère e con una tensione d
300 volt - su un resistore esterno di 3

ohm; nel contempo, i dischi rotanti della macchina hanno una potenza meccanica molto bassa che non supera 1 watt.

Lavorando con motori elettrici da tanti anni sono in grado di stabilire la potenza meccanica di un motore (ovviamente con approssimazione) con le sole mani. I dischi della TESTATIKA si possono fermare facilmente con un dito, mentre ognuno sa bene che il rotore di un qualunque altro generatore che produca 3 kilowatt di energia elettrica ti spezzerebbe tutte le dita se si tentasse di fermarlo con le mani.

Da ciò si deduce che l'autogeneratore TESTATIKA rivela una potenza meccanica frenante che non corrisponde all'energia elettrica fornita.

Ho fatto anche questo esperimento decisivo: ho messo la macchina in rotazione con alcune spinte iniziali della mano, quindi l'ho lasciata ruotare - senza che consumasse energia elettrica - lasciando aperti i due elettrodi d'uscita dei grandi condensatori. Poi ho collegato un resistore esterno a questi elettrodi d'uscita: immediatamente il resistore ha iniziato a scaldarsi, ma la macchina non ha mostrato alcuna variazione nella rotazione.

E' noto che, invece, con un generatore convenzionale in un caso analogo si avrebbe una diminuzione della velocità rotativa.

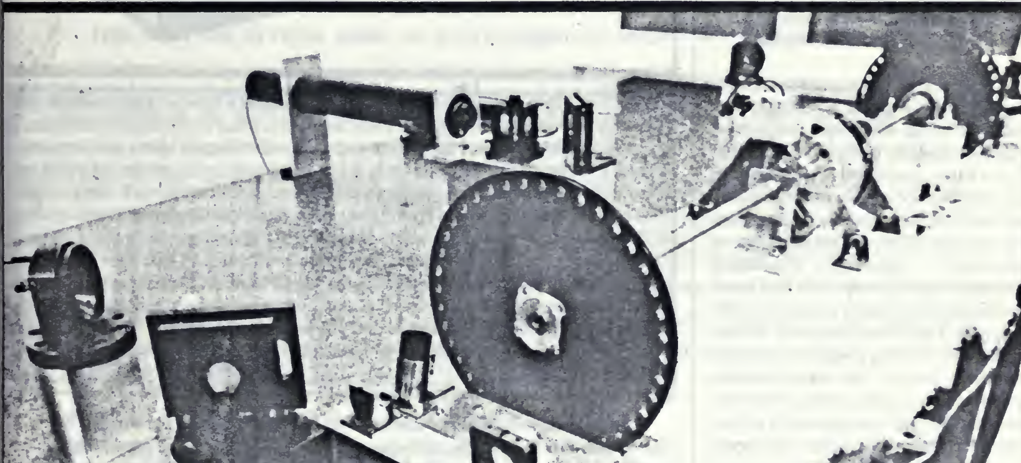
Questo dimostra che l'autogeneratore TESTATIKA non frena quando produce energia elettrica.

Come si spiega questo strano effetto, che, peraltro, ho rilevato - anche se in misura molto debole - nelle mie macchine ADAM e MAMIN COLIU? (Apparatus Discovered in Austria by Marinov e MArinov's Motional-transformer INductor COupled with a LIghtly rotating Unit - vedi TWT-II e IV).

Mi sono costruito, con poche ore di lavoro, un motore elettrostatico ed ho visto che comincia a ruotare solamente quando la tensione fornita (da un condensatore caricato o da qualunque sorgente di tensione costante) supera il valore di alcune migliaia di volt.

Dunque per me era chiaro che se questo mio motore caricasse con influenza un condensatore con una tensione di alcune centinaia di volt, sul disco non apparirebbe alcun momento frenante apprezzabile. Paul Baumann ha fatto esattamente questo: con il suo generatore di influenza carica con bassa tensione condensatori di grande capacità (condensatori speciali che ho visto per la prima volta).

Durante questa carica non agisce nessun momento frenante apprezzabi-



L'esperimento *coupled shutters* con il quale Marinov ha misurato, a Graz, la velocità assoluta della Terra ottenendo (nel febbraio del 1984) la grandezza $v = 360 \pm 40$ km/sec, con coordinate equatoriali dell'apice $\delta = -24° \pm 7°$, $\alpha = 12.5h \pm 1h$. Einstein dice che non si può fare una sincronizzazione istantanea di due eventi in due posti diversi... mentre ogni bambino è in grado di realizzare questa sincronizzazione con due dischi perforati solidali ad un asse rotante. (Ogni bambino, ma non i *rinoceronti* dei megalaboratori!)

le sul disco della macchina. E siccome la quantità di elettricità immagazzinnata nei condensatori è notevole, il resistore collegato ai loro elettrodi fornisce una notevole energia termica.

La macchina TESTATIKA ha diversi condensatori (nel modello a due dischi il loro numero arriva a 10), che, secondo me, sono di due tipi: i condensatori di piccola capacità sono caricati ad alta tensione (migliaia di volt) e sono quelli che si autocaricano e che creano il momento propulsivo dei dischi; quelli di grande capacità, che forniscono energia libera, sono caricati a bassa tensione (alcune centinaia di volt) e non creano momento frenante sui dischi rotanti.

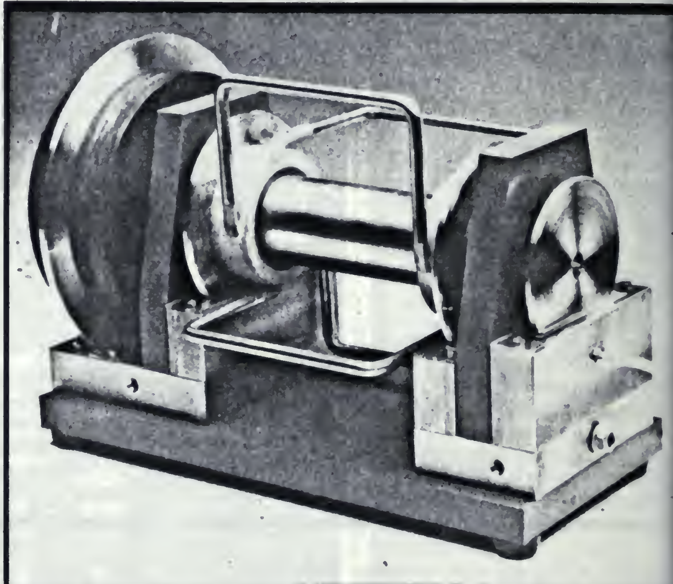
Dunque, secondo me, il "segreto" della macchina TESTATIKA è molto semplice, ma se Baumann è il primo uomo su questa terra che l'ha scoperto, allora dobbiamo ammettere che o lui è una persona divinamente illuminata o noi siamo estremamente stupidi.

Come si spiega la stranezza che nessun fisico sia riuscito a realizzare un moto perpetuo sulla base dell'elettrostatica? Penso che la risposta stia nel fatto che tutti i costruttori di generatori di influenza hanno cercato di caricare condensatori ad alta tensione per mostrare gli stupendi effetti che tali alte tensioni producono (i generatori d'influenza contemporanei, del tipo van de Graaff, producono tensioni di milioni di volt). Tali generatori hanno momenti frenanti notevoli. D'altra parte, i motori elettrostatici, data la loro bassa potenza meccanica, non possono far concorrenza ai motori elettromagnetici, la cui potenza meccanica può essere sviluppata a volontà. Questa è la ragione per cui l'umanità costruisce praticamente solo motori elettrodinamici, mentre i motori elettrostatici costituiscono solo una curiosità.

In questi ultimi anni uno scienziato americano di origine russa, Oleg Efimenko, ha realizzato diversi motori elettrostatici di questo tipo.

Sono stati realizzati anche motori elettrostatici con un lungo filo verticale (decine di metri) usando come sorgente energetica il gradiente del campo elettrico terrestre (si sa che il campo elettrico terrestre cambia di 100 volt per metro verticale).

Ma la macchina TESTATIKA non ha un simile tipo di "antenna".



La macchina R.A.F., costruita da Marinov nel 1988 a Graz, che presenta un ponte di Ampère rotante con contatti striscianti e un disco di Faraday cementato. Il ponte di Ampère rotante è un elettromotore senza statore. Il rotore qui sopra ruota perché le forze magnetiche, con le quali le correnti nelle *gambe* dei ponti agiscono sulle correnti nelle *braccia*, creano un momento rotativo, ma le forze magnetiche con le quali le correnti nelle *braccia* agiscono sulle correnti nelle *gambe*, NON creano un momento rotativo, a causa della violazione della terza legge di Newton nell'elettromagnetismo. Qualunque bambino può calcolare queste forze, procedendo dall'equazione fondamentale di Lorentz. Solo gli scienziati, con le loro teste grandi come sincrotroni, sono incapaci di farlo e dicono (vedi *The Thorny Way of Truth* di Marinov) che il ponte di Ampère rotante non può ruotare.

(A questa macchina è dedicato il n.25 degli *INEDITI*, della Soc. Ed. Andromeda, Bologna)

E' inutile anche ipotizzare che essa riceva energia dalle onde elettromagnetiche o dalle particelle cosmiche che attraversano la nostra atmosfera. Nessun fisico sarebbe in grado di risolvere tecnicamente il problema con tale tipo di energia, né riuscirebbe a mettere in moto un disco che non ha nessun contatto strisciante (l'unico contatto del disco rotante di plastica con la macchina è costituito dai cuscinetti a sfera su cui ruota).

Non si può che concludere, dunque, che la TESTATIKA è un *PERPETUUM MOBILE* classico e, ovviamente, viola la legge di conservazione dell'energia. La TESTATIKA separa gli elettroni dagli ioni in un pezzo di metallo senza consumare energia di qualunque tipo e possiamo solamente constatare come essa produca energia elettrica dal niente.

THE WIMSHURST MACHINE

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Abstract. I present the Wimshurst machine constructed recently by me. The Wimshurst machine is generator of current and not generator of tension, as all chemical and electromagnetic generators are. Only for very high loads it becomes generator of tension (for loads higher than 100 MΩ). The current generated by my machine is low (tens of micro-ampere) and I was unable to make it producing high current, as is the case with the machine TESTATIKA. Neither I could make it producing more electrical power than the electrical power needed for driving its d.c. motors. To be able to close the energetic circle and make it self-rotating (perpetuum mobile), I am planning to couple the Wimshurst generator with an electrostatic motor (already investigated by me) whose driving current is very low and the driving power much less than the driving power of electromagnetic motors manifesting the same torque.

According to my opinion (Ref. 1, p. 35) the machine TESTATIKA represents an influence generator (of the kind of the Wimshurst machine) coupled with an electrostatic motor (of the kind of the Grüel-Poggendorff motor). The "coupling" is such that the disk (disks) of the generator is (are) the same as the disk (disks) of the motor.

To understand better the essence of this "coupling", I separated the disks of the generator from the disks of the motor, thus to be able to measure better the generated and driving currents and tensions. In the case that the energy output of the generator will become bigger than the energy input of the motor, to close the energetic circle and to run the machine eternally (perpetuum mobile).

In Ref. 1, p. 22 I presented my electrostatic motor.

Now I shall present my Wimshurst generator.

In the near future I am planning to couple generator and motor by mounting the generator and motor disks on the same axle and by using the electric output of the generator as electric input of the motor.

The impetus for this experimentation came from Mr. Albert Hauser. On the 12 and 13 December 1989 I was in Copenhagen to deliver a lecture organized by the Danish Institute for Oecologic Technique. I had there a long conversation with A. Hauser who showed me photographs of his Wimshurst generator (fig. 1). Mr. Hauser has arrived at very good parameters and I realized that perhaps soon he will be able to close the energetic circle and to make a self-running machine.

Mr. Hauser told me also about another Dane, Mr. Tom Olsen, who, moved by Hauser's report on the machine TESTATIKA, has constructed an influence generator with one rotating disk which achieved excellent parameters. Tom Olsen's generator gives such a big electrical output that he can make glow three bicycle bulbs, any of which consumes current 0.05 A under a tension of 6 V, i.e., the heat power delivered by all three bulbs being 0.9 W. I was amazed to hear that Tom Olsen, by the help of a single one-wheel generator, rotating with some 3 - 4 rev/sec and having disk's diameter of some 20 - 30 cm, has been able:

1) to produce such a big power,

2) to produce such a high current under a low tension, as, normally, the influence machines produce low current and the tension depends only on the value of the load. According to me, an influence generator producing high current under low tension cannot have an electric braking and with the 1-watt-power of Olsen's machine one would very easily be able to drive the generator's disk by a d.c. motor.

Thus I realized that the construction of another electrostatic perpetuum mobile apart from TESTATIKA is imminent and, after my return to Graz, I phoned to Mr. Hauser to say that I shall also construct my own machine and I make with him a bet: who will be the first to run his machine eternally.

. .....

Thus in this paper I shall present only my Wimshurst generator whose drawings are given in figs. 2 and 3, and the photograph in figs. 4 and 5, repeating that my electrostatic motor was presented in Ref. 1, p. 22.

The theory of the Wimshurst generator is given on pp. 14 - 20 of Ref. 1. Comparing figs. 2 abd 3 with fig. 5 on p. 17 of Ref. 1, one easily sees that the diametrically connected electrodes s, s' and q, q' in fig. 5 of Ref. 1 are the diametrically connected electrodes C, D and E, F in fig. 2. The collecting electrodes P, P' in fig. 5 of Ref.1 are the collecting electrodes A, B in figs. 2 and 3. The two oppositely fixed electrodes A, A' (respectively, B, B') are connected by wires ending with plugs which are inserted in the respective holes of the electrodes. The electrodes C, D, as well as the electrodes E, F, are connected mutually in a similar way. In the machine there are no sliding contacts, however I was unable to produce electric current without making the electrodes C, D, E, F sliding.* My sliding electrodes were many-wire conductors which can be seen fixed to the electrodes C, D, E, F, in figs. 4 and 5.

In my Wimshurst machine every wheel (with radius 13 cm) is driven by its own d.c. electromotor (for nominal tension 24 V). In this way the mechanical friction which inevitably appears in any Wimshurst machine with counter-rotating wheels is diminished but the ohmic losses in the electromotors are increased, as the resistance of two motors is twice the resistance of one. Both motors, if driven by the same current, rotate with the same rate in opposite directions. If the rotation rate of one of the motors becomes lower, one can increase it quickly by short-circuiting the electrodes of the other motor.

To make the machine more effective, i.e., to make it separating for one revolution a greater quantity of electric charges, the metal (brass) sectors are put in holes in the

*Later I established that at higher tension the electrodes can be made non-sliding.

plastic (PVC) disks. In this way the surfaces of the rotating metal sectors pass very near one in front of another. The metal sectors in one of the disks go through the whole thickness (6 mm) of the wheel, while in the other only through a thickness of 5 mm and 1 mm thickness of the plastic remains as insulator between the oppositely charged sectors (see fig. 5 on p. 17 of Ref. 1).

By feeding both electromotors connected in series with about 0.1 A current under tension 10 V (i.e., with power 1 W), their rate of rotation was about 3 rev/sec.

My Wimshurst generator for low ohmic loads (lower than 100 MΩ) is a generator of current and the current in the load does not depend on the load's resistance. The biggest current is generated when the electrodes C and E are connected with the electrode A and the electrodes D and F are connected with the electrode B. At the rate of 3 rev/sec my machine produces about 10 μA. With the increase of the rotational rate the produced current increases.

As load I used my voltmeter. In table 1 there are given the voltmeter's resistances (column 2) for the different measuring ranges (column 1). The additional resistances connected in series with the voltmeter are given in column 3, the readings of the voltmeter are given in column 4, the current going through the circuit is given in column 5, and the power delivered as ohmic heat in the whole load is given in column 6.

Table 1

Range of the voltmeter V	Voltmeter's resistance MΩ	Additional resistance MΩ	Reading of voltmeter V	Current μA	Power mW
0.3	0.01		0.1	10	0.001
3	0.1		1	10	0.01
30	1		10	10	0.1
300	10		100	10	1
300	10	90	90	9	8.1
300	10	990	30	5	25

If the machine will remain generator of current also for high resistances, one can easily make it producing more electric power than the electric power consumed for driving the electromotors. Indeed, if for load $R = 10$ GΩ $= 10^{10}$ Ω the generated current will remain $I = 10^{-5}$ A, then the tension over this resistance will be $U = 10^5$ V and the produced heat power will be $P = 1$ W. However, as table 1 shows, the tension on the collecting (output) electrodes cannot overpass a certain limit (in my machine about $U_{max} = 5000$ V - see the lower road in table 1).

It is clear that, <u>for a given construction</u>, the output tension can be not increased over a certain limit at which charges from the sectors do not jump more on the collecting electrodes A, B. I saw that when the tension on the collecting electrodes increased, discharges could be seen across the PVC-insulator between the sectors on both counter-rotating wheels. Thus in the machine which I intend now to construct I shall put a very good insulator (cardboard for transformers) between both counter-rotating disks. I must add that to have high generated current, the metal sectors on the counter-rotating disks must pass very near and, consequently, the insulator plate has to be thin. This is a very important controversy. For comparison I can add that the Wimshurst machine of the Graz university (constructed, probably, at Boltzmann's time) which can be seen on pp. 22 and 23 of Ref. 1 produces easily tensions up to 50 kV but the generated current (at low-resistance-load) is lower than 5 μA. In the university-machine the sectors on the counter-rotating disks are far one from another and have a good insulator between.

I tried to see whether my Wimshurst machine has an electric braking in the following way: After having set the machine at a definite rate of rotation, I measured the coasting down times at open collecting electrodes (no power production) and when closing them by a resistance of 1 GΩ (power production P_{out} = 25 mW). As the ohmic resistance of both electromotors was R_i = 54 Ω, the power delivered as heat in the windings of the rotors at current I = 0.1 A and applied tension U = 10 V was $P_{heat} = I^2R_i = 0.54$ W ≅ 500 mW, and thus the remaining power P_{mech} = 500 mW was the power overwhelming the friction in my machine. Hence the produced electric power P_{out} was 1/20 part of the mechanical friction power P_{mech}. However, the coasting down times in both above mentioned cases were quite equal (about $2^m\ 48^s$). Here the objection can be made that at open collecting electrodes there is nevertheless power production over an infinitely large resistance through the air but when I measured the coasting down time without errecting the machine, by disconnecting the electrodes C, D and E, F, some $3^m\ 18^s$ have been obtained. Thus I established that my machine has a low electric braking but I must add that the relation P_{out}/P_{mech} = 0.05 was pretty low. I advise the reader to read the article of Rossetti on p. 180 and the chapter on p. 231 of Ref. 1.

I do not see a way on which I can make an influence machine producing high current, as is the case with the machine TESTATIKA and with the machine of Tom Olsen. Thus I shall make my new Wimshurst machine again low-current producing but I shall try to increase the maximum tension on its collecting electrodes up to some 40 kV and then I shall couple it with an electrostatic motor which will need for its rotation some few microampere.

REFERENCE

1. S. Marinov, *The Thorny Way of Truth, Part V* (East-West, Graz, 1989).

ADDITIONAL NOTE. I constructed a Wimshurst machine coupled mechanically (and electrically) with an electrostatic motor, however for the same electric output, respectively, electric input power the braking mechanical power of the Wimshurst machine is some 4-5 times bigger than the driving mechanical power of the motor. There are ways for increasing the driving power of the motor (at the same consumed electric power), but I have no money for making a motor with better parameters. The report on the constructed machine will be presented in TWT-VIII.

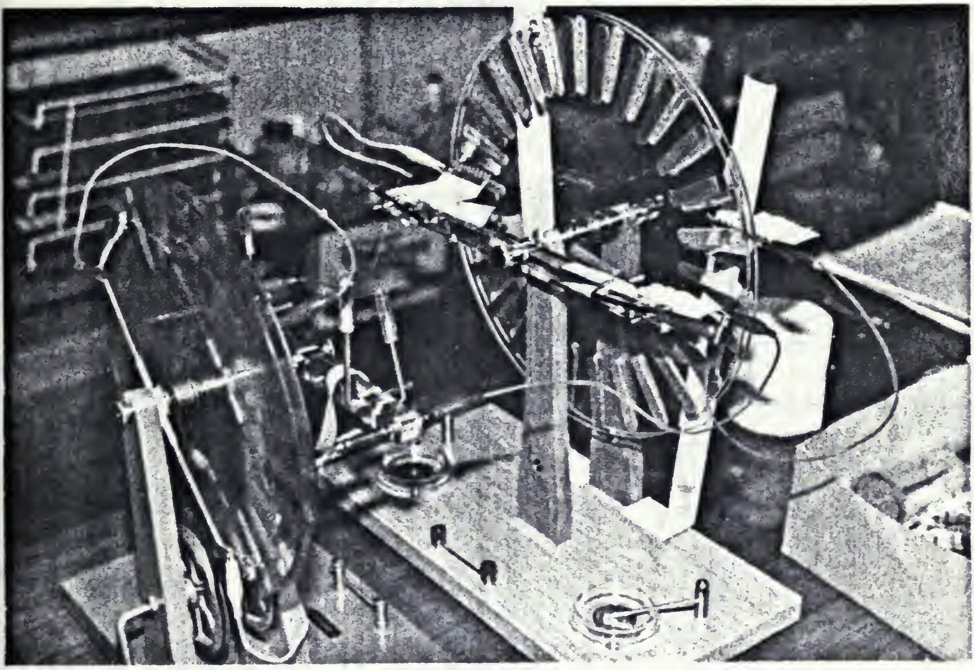

Fig. 1. Albert Hauser's Wimshurst generator (two machines).

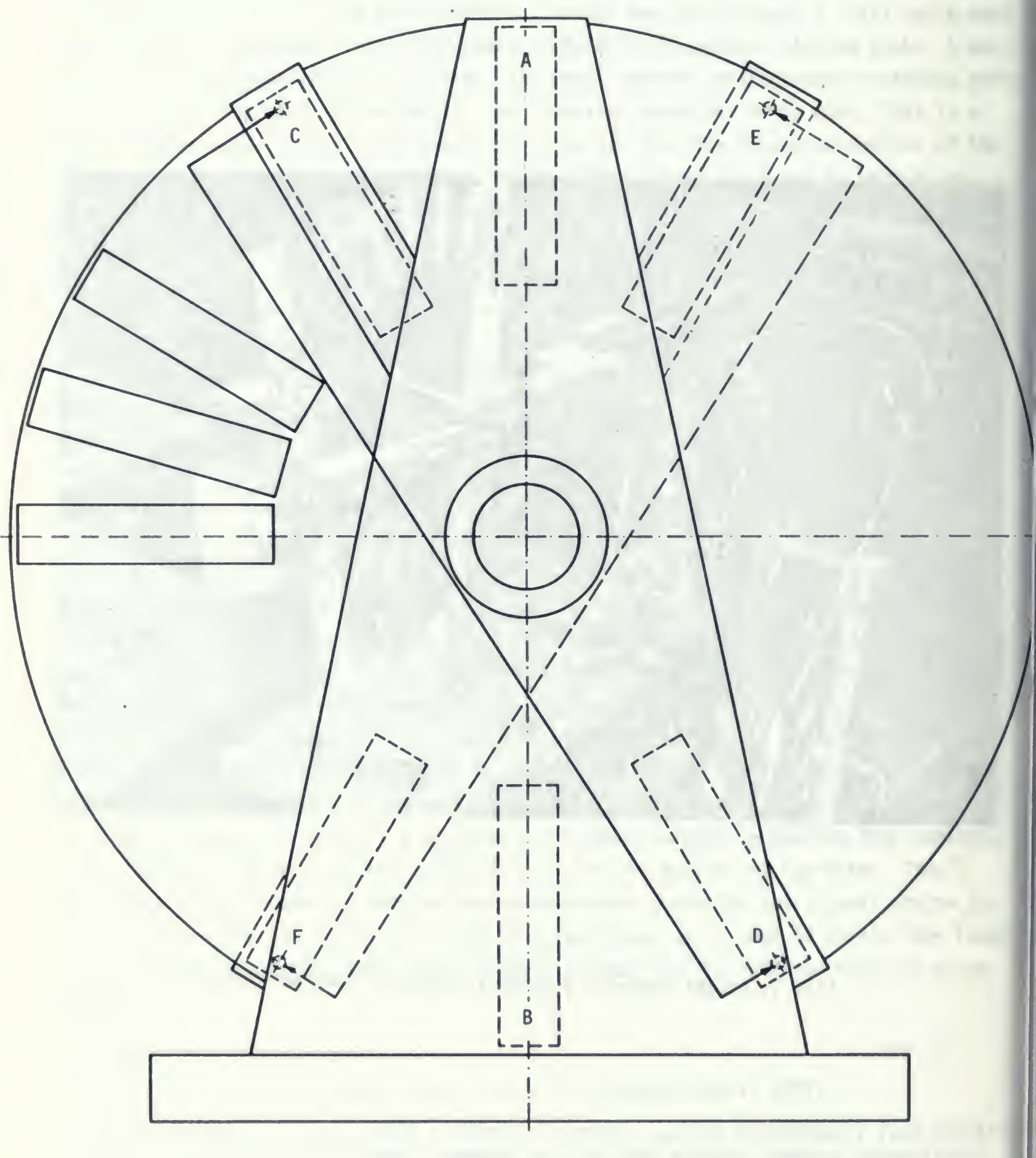

Fig. 2. Marinov's Wimshurst machine (side view).

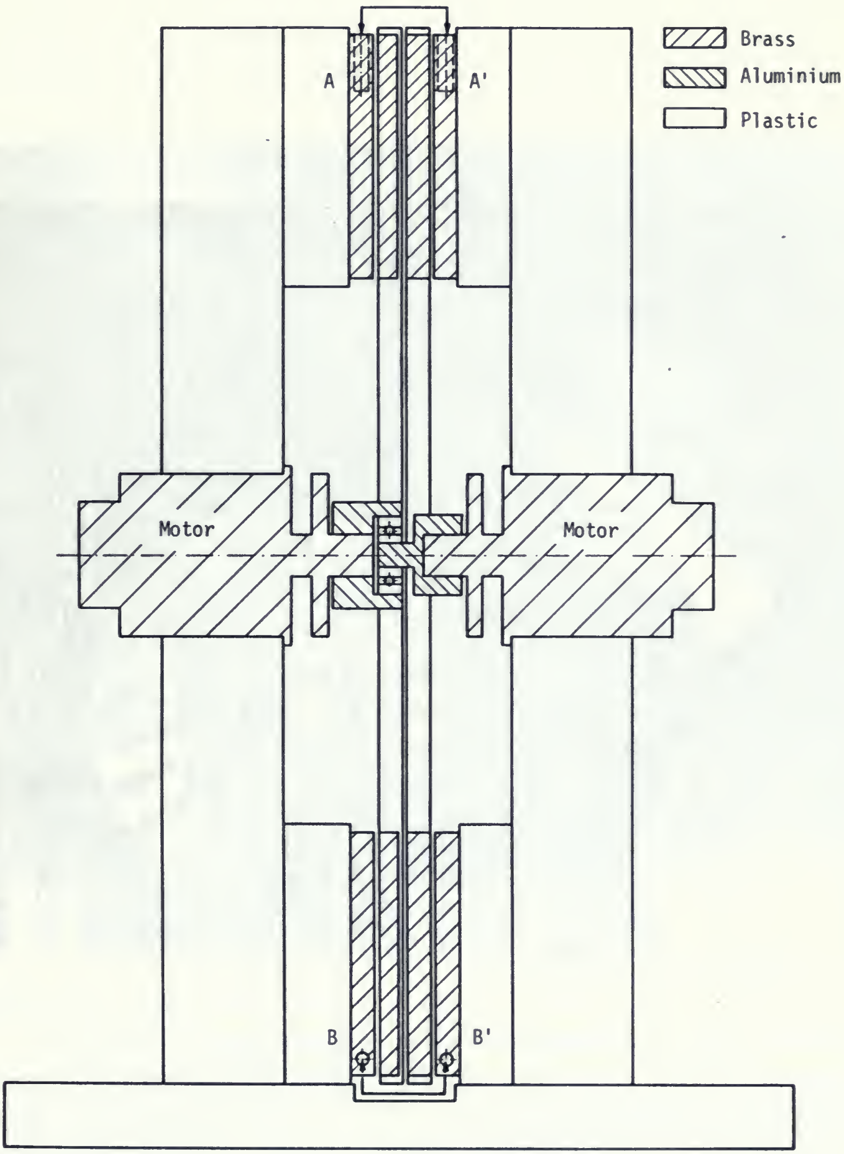

Fig. 3. Marinov's Wimshurst machine (cross-section).

Fig. 4. Photograph of Marinov's Wimshurst machine (side view).

There are certain unsubstantial technical differences between the drawings (figs. 2, 3) and the constructed then machine (figs. 4, 5). So the electrodes are not fixed directly to the supporters (as in figs. 2, 3) but to plates fixed to the supporters whose distances to the rotating wheels can be adjusted at will.

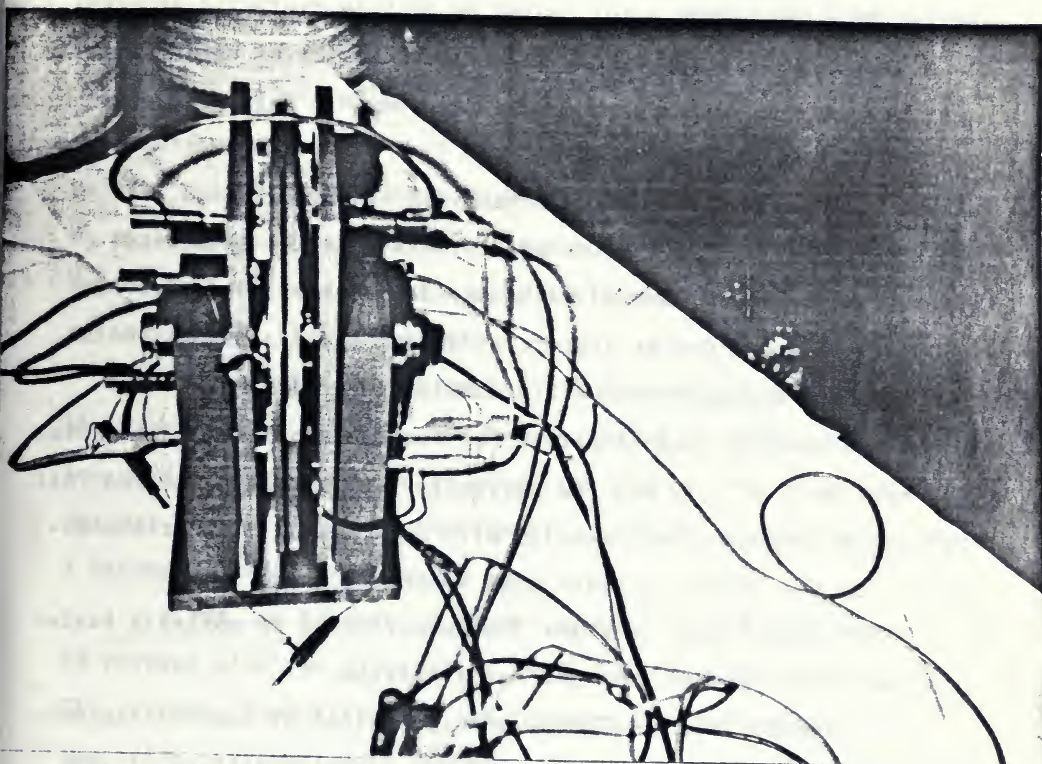

Fig. 5. Photograph of Marinov's Wimshurst machine (front view).

ADDITIONAL NOTE. The reasons that the above machine cannot generate high tensions are three:

1) The sectors on the wheels are too near one to another and discharges bewteen the electrodes can "jump" from one sector to another.

2) The PVC insulator between the wheels is no good and discharges go through it.

3) Because of the THICK sectors, the collecting electrodes charge by influence the near surface of the "under-electrode" sector by opposite electricity and thus discharges appear between the electrode and the sector.

It is worth to be noted that the machine TESTATIKA has thick sectors ONLY ON ONE of the wheels (the electrically connected GRID-sectors are on BOTH sides of the plexiglas wheel), and thin sectors on the other wheel which are only on the ONE (external) side of the second wheel. Moreover, the surfaces of the slightly magnetized sectors are covered by insulating spray.

ONCE MORE ABOUT COLD FUSION

An attempt was made to explain cold fusion with decomposition on He^3, He^4 and neutrons of some cathode's nuclei by penetration of D into them.

Notes about cold fusion in less then 3 months caused oscilliations between violent enthusiasm and complete negation in the emotions of the physicists.

In all experiments, connected with the cold fusion, one observes electrolytic infusion of deutrons into the cathodes. Fleischmann and Pons[1] use Pd cathodes, Jones et al.[2] besides Pd introduce Ti and Gründler (report at one of the discussions on the cold fusion) announces about Li containing Pd ones.

The results (unfortunately not confirmed by all experiments) show that He^3, He^4, Ti and low energetic neutrons are observed. All the authors explain these results with cold fusion of deutrons according to the schemes already well known.

L.Pauling[3] only proposes decomposition of an unstable Palladium deuteride, formed into the metal lattice.

We should like to propose an explanation of some of the mentioned experimental results on the basis of decomposition of some cathode's nuclei.

We assume (according to a hypothesis, that will be published) that some nuclei are composed of smaller and comparativelly independent ones, sometimes binded up with neutrons, which may be considered as substructural units. We also suppose, that there exists a posibility for a particle or a small nucleus, with proper size and energy, to penetrate into a greater one, to cause its destabilisation and thus to liberate the substructural units and the neutrons, that joint them.

Further we assume, that just He^3 and He^4 are the substructural units binded with neutrons, which form only some isotopic nuclei of Pd, Ti or Li and can be liberated by D penetration. These isotopes are Pd^{102}, Pd^{104}, Pd^{106}, Pd^{110}, Ti^{46} and Li^6 among the stable ones as well as Ti^{44}, which has a large half life. Their probable structure will be an object for a future discussion. It is important to remark here, that according to the hypothesis proposed above Pd^{102}, Pd^{104}, Pd^{106} and Pd^{110} can be composed of He^3 and neutrons only, Li^6 - of He^4 and D, Ti^{46} of He^4 and neutrons. But Ti^{44} can be formed both by He^3 and He^4 in various combinations. At their destabilisation, as a result of the penetration of D, He^3, He^4 or both He^3 and He^4 should be liberated as well as neutrons, as observed in the experiments.

Before making an attempt for a theoretical explanation of the experimental results, and before trying to answer the question how deutrons surmount the Pd potential barrier, we would like to suggest some reasons and experiments, that could be decisive for a decompositional hypothesis.

First, we propose to repeat some of the experiments realised at present with the possibility to follow the cathode's weight. The isotopic composition of the cathodes material used (if not specially enriched) must resemble the natural one. That means Pd cathodes contain Pd^{102} about 1%, Pd^{104} - 10%, Pd^{106} - 27% and Pd^{110} - 12%. Ti and Li cathodes contain Ti^{46} and Li^6 about 8% respectively.

When a compositional reaction takes place, one or several isotopes can participate and so they can be exhausted. Decomposition of Pd^{104}, Pd^{106}, Pd^{110}, Ti^{46} or Li^6 could be comparatively easily established by means of the cathode weight (for example 10% of 3 g are 0,03 g, while 27% are 0,71 g). It would be more difficult (but we hope not impossible), to do the same in case of desintegration of Pd^{102} or for Ti^{44}. We regard the assertion of Celani et al. (at one of the discussions upon the cold fusion) of some disappearing of Pd (approximately 10% in volume) as a possible illustration for the Palladium decomposition and not for cold fusion. The assertions of about all the authors who state, that after some time the reaction practically ceases, confirm the decompositional hypothesis, too: a partitional reaction would stop when the isotop (or isotops) come to an end.

Thus, it seams suitable that the isotopic composition of the electrodes should also be familiar in advance. Besides, it may be possible to explain the poor reproduction of the experimental results by means of the different isotopic composition of the cathodes.

Second, we suggest, that electrodes of pure Pd^{102}, Pd^{104}, Pd^{106}, Pd^{110}, Ti^{46} or Li^{6} should be used, if possible.

In all these cases we propose D_2O or T_2O as electrolyte, that is to work with D or T, which would be very proper for destabilisation of the nuclei.

At last we suggest the experimental set-up to be changed as follows: the cathode to be placed in volume full of D or T. It could be made of Pd, Ti or Li, but Pd^{102}, Pd^{104}, Pd^{106}, Pd^{110}, Ti^{46} or Li^{6} are preferable. The weight variation of such an electrode (and the appearance of neutrons) may be an indication for a decompositional reaction. We assume that Menlove[4] has realized the third proposal: he announces, that his group had detected low neutron fluxes, when they had simply placed Pd and Ti in the form of powder in high pressure deuterium gas.

All our suggestions would be enough to confirm or to reject the hypothesis for a decomposition of Pd, Ti or Li nuclei as a result of D or T penetration into them.

1. Fleischmann M., Pons, S. - J.Electroanal. Chem., 261, 301-308, 1989.
2. Jones, S.E. et al. - Nature, 338, 737-740, 1989.
3. Pauling, L. - Nature, 339, 105, 1989.
4. Menlove, H. - Nature, 339, 325, 1989.

MEDAREVA MARIA

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MARINOV'S COMMENTS ON THE PREVIOUS PAPER BY M. MEDAREVA

I am not a specialist in nuclear physics and I am unable to give some valuable comments on Dr. Medareva's paper (but who would be able!?). I wish only to note that according to the last public declaration of Fleischmann and Pons, NUCLEAR FUSION DOES NOT TAKE PLACE AT ALL in their electrolytic experiment.

Now Fleischmann and Pons affirm that the liberated (output) heat energy in their experiment, in excess to the input electrical energy, is nothing else than FREE ENERGY, i.e., energy CREATED FROM NOTHING (although until now there are not confirmations of other scientists that in such kind of experiments the output heat energy is indeed in excess with respect to the input electrical energy!).

The whole this story looks highly amusing!

I am wondering only why we, the "free energy" physicists, who do simple, clear, easily repeatable and childishly calculable experiments, violating the laws of conservation, and who have in the hands a running perpetuum mobile machine (the machine TESTATIKA), are considered as cranks, meanwhile Fleischmann and Pons, who do unclear, unrepeatable and uncalculable experiments are taken seriously by the scientific community. Perhaps the reason is that Fleischmann and Pons wear spectacles and have a more intelligent look!?

Concerning the different kinds of "explanation" of the "cold fusion", which allegedly Fleischmann, Pons and Jones have "observed", I shall suggest to Dr. Medareva the absorbing reading at the bottom of p. 283 of TWT-VI.

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Ext. 107

15th November, 1976

Dr. S. Marinov,
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ul Elin Pelin 22,
Sofia 1421,
BULGARIA.

Dear Dr. Maninov,

Thank you for your announcement of 1 November 1977, giving information relating to the forthcoming conference, in Vama, 5 - 15 May, 1977.

I wish to take part in the conference, and I therefore enclose the complete application form. I shall pay the 50 Dollar participation charge as soon as my bank can arrange for the payment to be arranged.

I shall send my contribution, in the form of typed notes as soon as possible. Should these be bound together in any way? Should the contributions be sent to your address in Sofia, or to some other address, in Vama, or elsewhere?

One further question - are the prices quoted in your information sheet <u>United States Dollars</u>, or dollars of some other currency? Would the hotel charges be payed beforehand, through the Bulgarian Tourist Agency, or upon arrival in Vama?

Might I say that I am glad that great interest has been shown in the conference - it should prove to be a most stimulating, and valuable enterprise.

Yours sincerely,

M. C. Duffy

M. C. Duffy
Lecturer

<u>Marinov's note</u>. If the reader will ask whether I publish this letter of Dr. M. Duffy of the 15 November 1976 to be compared with his letter of the 1 September 1988 (see p. 242 of TWT-IV), the answer is: NO. The above Duffy's letter is reproduced here (I found it during my sojourn in Sofia in September 1989), so that the readers of TWT can see that for Dr. Duffy there is a problem when some price is given in dollars whether one means USA dollars, or Australian dollars, as all realtivists are people creating problems there where for ANY CHILD there is no problem. Indeed when I ask at the black money-market in Sofia some child how many leva will he give me for one dollar, I have NEVER heard a question: "For an American or for a Patagonian dollar?"

The American Physical Society

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Editor-in-Chief

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July 12, 1989

Dr. Stefan Marinov
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Dear Dr. Marinov:

Thank you for your letter of June 25, 1989 which was just forwarded to me at the APS Editorial Office.

I explained our editorial procedures in my previous letter. These policies have been in effect for at least a half-century and are not subject to ad-hoc alteration. The Editor of each journal has the ultimate authority to acept or reject papers based on his own judgment, aided, most often, by the opinons of outside referees. Dr. Basbas, accordingly, has the right to reject any of your papers without presenting his reasons. I cannot ask him to reexamine this decision.

I believe that your papers are so far outside the mainstream of modern physics that there is little use in your continuing to submit them to Physical Review or Physical Review Letters. It seems very unlikely that any of our referees or editors would find them acceptable. I strongly suggest that you find another journal to publish your work.

Regarding your books which were returned to you, I can only assure you that we did not buy them for valid reasons, not, as you have presumed, to suppress them. Our library is very small and private, available only to the staff of the editorial office.

I wish you success in finding another suitable publisher for your scientific papers.

Sincerely yours,

David Lazarus
Editor-in-Chief

xc: G. Basbas
D. Nordstrom

STEFAN MARINOV
Morellenfeldgasse 16
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19 July 1989

Dr. Robert Romer
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MA 01002

Dear Dr. Romer,

First I should like to use the occasion and to ask you whether you have received my letter of the 22 October 1988, as no acknowledgement for the reception of my paper ABSOLUTE AND RELATIVE NEWTON-LORENTZ EQUATIONS has reached me. Please, be so kind to inform me, has this letter reached you or not. In the case that the letter has reached you, please, write me which is your decision about the acceptance/rejection of my paper.

Now I submit to the AJP my paper

THE DEMONSTRATIONAL MOLLER-MARINOV MACHINE.

I send the paper in one copy as I hardly believe that you will send it to more than one referee.

I attach a copy of my paper "Experimental violations..." published in the INT. J. GEN. SYSTEMS, **13**, 173, 1987, as in this paper is described the demonstrational Faraday-Barlow machine invented and constructed by me which is cited in the submitted paper.

I enclose also the covers of the last three volumes of my series THE THORNY WAY OF TRUTH, namely: Part IV, published in January 1989, Part V, published in May 1989 and Part VI, published in July 1989. Please, take into account that any book has MORE than 300 pages. If you would like to order some of the books of my sequence, send $ 25 for any volume (+ $ 5 for air mail).

Hoping to receive your acknowledgement for the reception of this letter and then in due time also your final decision on my submitted paper,

Sincerely yours,

Stefan Marinov

<u>Editorial note</u>. Marinov's letter of 22 October 1988 is published in TWT-IV, p. 277.
The above letter is answered by Dr. Römer with a letter of the 1 August 1989.

STEFAN MARINOV
Morellenfeldgasse 16
A-8010 GRAZ — AUSTRIA

25 July 1989

Prof. Bengt Nagel
Nobel Committee for Physics
Sturegatan 14
S-114 36 Stockholm

Dear Dr. Nagel,

I send you the VI-th volume of my book THE THORNY WAY OF TRUTH and I beg you to acknowledge the reception.

I use the occasion to thank you for your letter of the 18th May (signed by Mr. Anders Barany) with which you acknowledged the reception of the previous volumes V and IV (a copy of this letter is enclosed).

As you can see, in this letter the Nobel Committee does not answer my question posed in my letter of the 3rd May (the letter is reproduced on p. 269 of TWT-VI) whether the Nobel Committee is interested to visit the first PERPETUUM MOBILE on the planet Earth in the village Linden. I beg you VERY MUCH to state in your answer whether you accept our invitation and whether you will send representatives of the Nobel committee for an inspection of the machine TESTATIKA, or the Nobel Committee is not interested in seeing this scientific WONDER. I think, posterity should like to know which was the attitude of the Nobel Committee to TESTATIKA.

I give you the advice, before giving the answer of the Nobel Committee, to peruse my correspondence with Dr. Maddox which is published in TWT-VI.

I shall be very obliged to you, if you will send me the decision of the Nobel Committee as soon as possible.

Sincerely yours,

Stefan Marinov

Editorial note. The above letter is answered by Prof. B. Nagel on the 15 August 1989.

STEFAN MARINOV
Morellenfeldgasse 16
A-8010 GRAZ — AUSTRIA

28 июля 1989 г.

Мой Телефакс: 0316/8257560
Мой Телекс: A-312275

Президенту АН СССР
Копии: 1. Академику Сахарову
2. Послу СССР в Вене
3. Послу СССР в Берне
4. Д-ру С. Панкратову

Уважаемый Господин Президент!

Пишу только Вам и посылаю копии этого письма выше перечисленным лицам, ибо нет смысла писать каждому в отдельности.

На мое письмо Вам от 18-го мая /см. приложенную книгу TWT-VI, стр. 273/, на мой телекс Вам от 6-го июня /см. TWT-VI, стр. 312/ и на мое письмо Вам, посланное гонцом из Граца, д-ром В. Дикаревым, нет никакого ответа.

Мой связной в Москве, д-р С. Панкратов, редактор журнала НАУКА И ЖИЗНЬ, бывал в Академии в Отделении Связей с Заграницей и на Отделении Общей Физики. Он сказал мне по телефону: "Когда речь заходит о вечном двигателе ТЕСТАТИКА, все здесь в Академии начинают киснуть." Думаю, пора уже всем этим лицам в Академии начать ЩЕЛОЧЕТЬ.

Я послал изобильную документацию о машине ТЕСТАТИКА и о швейцарской коммуне МЕТЕРНИТА, где эта машина построена. Первые два прототипа, как я уже объяснял, были построены Паулем Бауманном в швейцарской тюрьме, куда он был брошен на семь лет по сфабрицированному процессу /швейцарское правительство активно содействовало этой фабрикации/, с целью дискредитировать и разрушить коммуну, где живут люди ВОЛЬНЫЕ на принципах христианского коммунизма, власть денег и власть государственную отвергающие. Вера, что только в братстве и в любви можно обрести счастье, благодать и покой, помогла этой кучке людей выстоять против нажима безмилостной государственной машины. Бескорыстным коллективным трудом они поставили коммуну экономически на ноги и показали, что не только социализм, но и коммунизм можно не только в одной отдельно взятой стране, но и в одной отдельно взятой деревне построить. В коммуне каждый трудится по своим способностям и каждый получает по своим потребностям. И двери коммуны открыты каждому, кто хочет жить в братстве и в любви, каждому, Господин Президент, и слепому и хромому. "Не может этого быть, воскликнете Вы из столицы советов на семидесятом году коммунистической власти, такое наступит через тысячу лет, да и то вряд ли."

Господин Президент, двери коммуны открыты. Приходите и посмотрите, может ли такое быть и то в стране, именуемой Швейцария, где франку кланяются и служат и кошка и мошка.

И вот в этой коммуне построен вечный двигатель. И построен он десять лет тому назад. Коммунары не хотят иметь ничего общего с западной прессой, которая вылила помои лжи и клевет, когда государство "боролось" с коммуной. Теперь государство "махнуло рукой", но желтая пресса продолжает к случаю или без случая выливать помои. Коммунары не хотят иметь ничего общего и с западными учеными, ибо считают, что они продают свои уменья и знанья дьяволу, с чем, думаю, согласитесь и Вы. Я сказал им, что есть в этом мире ученый, который продавал свои знанья и уменья дьяволу, но потом отвернулся от зеленоглазого и зеленоглазаму в лицо плюнул. Имя этого человека Сахаров. А теперь и вся страна Советов от зеленоглазого отворачивается. "Давайте, предложил я, пригласим Сахарова и Президента Академии Наук СССР, чтобы они на машину ТЕСТАТИКА посмотрели и потом оповестили бы миру о великом открытии." Коммунары подумали, подумали и сказали "Давай".

И вот я пищу письма, посылаю книги, документацию, стучу телекс, посылаю связного из Москвы, гонца из Граца, а чиновники в Вашей академии "киснут". Прочее, вижу, что тщетно обращаться в Академию страны Советов по-дружески, по-братски, так как коммунары обращаются один к другому. Видно без "рычагов" капитализма нам не обойтись. Жаль, товарищ Президент, жаль, что Советская академия относится с таким пренебрежением к коммуне в Швейцарии и лично ко мне, бедному австрийскому конюху, который с неимоверными усилиями, жертвуя последним куском хлеба на эксперименты, борется за научную правду.

Поэтому вынужден обратиться со следующим предложением: Мы приглашаем советского /их/ академика /ов/ приехать в деревню Линден и посмотреть на машину ТЕСТАТИКА. Если посетивший коммуну опубликует потом в одном из журналов ИЗВЕСТИЯ, ОГОНЕК, МОСКОВСКИЕ НОВОСТИ, НАУКА И ЖИЗНЬ фотографию, где он снят перед машиной, с декларацией, что по его мненью эта машина не вечный двигатель, то мы заплатим советской академии 20,000 долларов. Если посетивший согласится, что машина вечный двигатель, покажем наш фильм по московскому телевидению с Вашим или Сахарова словом. К Сахарову таким "рычагом" обращаться не могу, ибо считаю его коммунаром. И к Вам не стал бы, но мои письма до Ваших рук не доходят, они застревают в руках чиновников. Мне нужно как-то перепрыгнуть через головы замзавов и прочих витязей стола. Прошу, чтобы ответ был подписан Вами или Вашим заместителем.

С комприветом: Стефан Маринов

AMERICAN JOURNAL OF PHYSICS

Robert H. Romer, Editor
Mark D. Semon, Assistant Editor
Karla Keyes, Assistant to the Editor

Merrill Science Building, Room 222
Box 2262
Amherst College
Amherst, Massachusetts 01002
(413) 542-5792

August 1, 1989

Dr. Stefan Marinov
Morellenfeldgasse 16
A-8010 Graz
AUSTRIA

Dear Dr. Marinov:

I have received your paper, "The Demonstrational Moller-Marinov Machine". Your cover letter also referred to an earlier submission of yours. You are correct in saying that we did not acknowledge receipt of the earlier paper. It must be clear to you from our statement of editorial policy that we do not consider papers which purport to overturn well-established bodies of theories such as the special theory of relativity. I note that your newest paper contains the claim that "This machine shows that the relativistic concepts of electromagnetism are wrong...". You will find our reasons, which I am sure you do not agree with, for not considering such papers in our Statement of Editorial Policy. We will not consider such papers, and we will not feel obliged to acknowledge receipt of papers submitted to us by authors who have been clearly informed about our policy about such papers.

I am sorry to be uncooperative, but if there are appropriate places for publishing papers such as this, this Journal is not one that will consider them.

Sincerely yours,

Robert H. Romer

Editorial note. With the above letter Dr. Römer answers Marinov's letter of the 19 July 1989.
Marinov gives his answer in a letter of the 8 December 1989.

STEFAN MARINOV
Morellenfeldgasse 16
A-8010 GRAZ — AUSTRIA

2 August 1989

Dr. David Finkelstein
IJTP
Georgia Institute of Technology
Atlanta
GE 30332

Dear Dr. Finkelstein,

I submit to your journal my paper (in a single copy)

THE MYTHS IN PHYSICS.

The Physics Abstracts class. numbers are 03.30 and 41.10.

Herewith I transfer the copyright for this paper to your journal.

All eventual charges will be paid by myself.

I use the occasion to thank you for your letter of the 4 January 1989 (date attached by me). I send a copy of this letter, so that you do not lose time to search for in your archives. I enclose also p. 16 of TWT-III referred to in my comments to your letter.

Maybe you have visited GR12 and you have read my abstract. I have not visited the conference because with a telefax of 29 June 1989 Dr. Neil Ashby did not allow me to present the 40-minutes film which we have drawn on the first perpetuum mobile in this world, the machine TESTATIKA. I begged Dr. Ashby to poster my letter, so that the participants can learn for WHICH reasons I did not visit the conference but I am not sure whether Dr. Ashby has postered my letter (better to say, I am sure that Dr. Ashby has not postered my letter).

Then I suggested to Dr. Ashby the following: In certain Bulgarian streets there is no the number 13. After the number 12 the number 14 follows. Thus I suggested to call the next GR-conference not GR-13 but GR-14. I do not know whether my suggestion was taken into account at the meeting of the organizing committee when discussing the problems about the next conference.

Hoping to receive your acknowledgement for reception and then in due time also your final decision,

Sincerely yours,

Stefan Marinov

PS. Enclosed are the covers of TWT-III, IV, V, VI edited in the last months (every book has more than 300 pages). If you or other persons in your institute are interested to acquire them, I shall gladly send the requested copies.

13 October 1989

Dear Dr. Finkelstein,

To the present day there is no answer of you to my above letter. Please, be so kind to inform me whether you have received my paper THE MYTHS IN PHYSICS and whether you will publish or reject it. In the case of rejection I should like to submit the paper to another journal.

Hoping to receive your letter as soon as possible,

Sincerely yours, S. Marinov

Stefan Marinov

Editorial note. The above letters are answered with a letter of 10 November 1989.

nature
INTERNATIONAL WEEKLY JOURNAL OF SCIENCE

Macmillan Magazines Ltd
4 Little Essex Street London WC2R 3LF
Facsimile 01-240 2408 Telex 262024

11/8/1989

Mr Stefan Marinov
Morelllenfeldgasse 16
A-8010 Graz-Austria

Dear Mr Marinov

Thank you for your letter of 26 July regarding your advertisement in Nature.

As your advertisement will not be published, I will arrange for your £950 to be returned as soon as possible.

Regards

Andy Sutherland

Macmillan Accounts and Administration Limited
Houndmills, Basingstoke, Hampshire RG21 2XS
Telephone Basingstoke (0256) 29242 Cables Publish Basingstoke Telex 858493

TO

STEFAN MARINOV
MORELLENFELD GASSE 16
A-8010 GRAZ
AUSTRIA

DATE 31-AUG-89

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WE HAVE PLEASURE IN ENCLOSING OUR PAYMENT FOR YOUR ACCOUNT MADE UP AS FOLLOWS

DATE	REFERENCE	AMOUNT
11-08-89	3587/024	950.00

Editorial note. The £ 950 sent by Marinov on the 8 June (see TWT-VI, p. 304) were returned indeed (on the 31 August), and NATURE cannot be blamed for small banditism. But will future generations judge NATURE and Dr. Maddox as slayers of scientific GLASNOST, where the losses are milliards and billions!?

NOBEL COMMITTEES FOR PHYSICS AND CHEMISTRY
THE ROYAL SWEDISH ACADEMY OF SCIENCES
Box 50005, S-104 05 Stockholm, Sweden

August 15, 1989

Dr. Stefan Marinov
Morellenfeldgasse 16 A-8010 GRAZ

Dear Sir,

This is to acknowledge receipt of your book Thorny Way of Truth Part VI with enclosed letter. You certainly know that the Nobel Committee is not supposed to check and give opinion on discoveries and inventions, not even perpetuum mobile machines (particularly not!)

Yours sincerely,

Bengt Nagel

Editorial note. With the above letter Prof. B. Nagel answers Marinov's letter of the 25 July 1989.

THUS THE NOBEL COMMITTEE REFUSES TO SEE THE FIRST PERPETUUM MOBILE ON THE PLANET EARTH. Herewith historians are asked to not heal this fact from future generations.

Luigi DiLella
Editor – in – charge
Int. Journal of Mod. Phys.A
Mod. Phys. Lett. A

Dr. Stefan Marinov
Morellenfeldgasse 16
A – 8010 GRAZ
(Autriche)

16 August 1989

Dear Dr. Marinov,

I have received your paper

THE ELECTROMAGNETIC EFFECTS ARE DETERMINED BY THE POTENTIALS AND NOT BY THE INTENSITIES

which you have submitted for publication in IJMP.

At first sight, the content of your paper appears to be in strong disagreement with gauge invariance. Nevertheless, I have given the paper to a referee who knows electromagnetism much better than I do and I shall inform you about his opinion and my decision in due course.

Sincerely yours,

Luigi DiLella

17 August 1989

Dear Dr. Marinov,

I have received the referee's report on your paper

THE ELECTROMAGNETIC EFFECTS ARE DETERMINED BY THE POTENTIALS AND NOT BY THE INTENSITIES

which you have submitted for publication in IJMP.

As expected, the referee does not support your paper for publication. His main arguments are:

1. Your electromagnetic theory is wrong;

2. The experiments which confirm your theory are wrong, because an infinite solenoid cannot be built in practice and so you must take into account the magnetic flux outside the solenoid, which has important effects for finite – size solenoids (a fact that you seem to ignore).

In conclusion, once again I must reject your paper

Editorial note. Marinov answers the above letter with his letter of the 22 August.

Sincerely yours,

Luigi DiLella

STEFAN MARINOV
Morellenfeldgasse 16
A-8010 GRAZ — AUSTRIA

22 August 1989

Prof. Luigi DiLella
Int. J. Mod. Physics
CERN
CH-1211 Geneve 23

Dear Prof. DiLella,

Thank you very much for your letters of the 16 and 17 August, although the rejection of my paper THE ELECTROMAGNETIC EFFECTS ARE DETERMINED BY THE POTENTIALS AND NOT BY THE INTENSITIES was, of course, not pleasant for me.

I am amazed how a referee of such a prestigious journal as yours can write such a bad referee's opinion. I should like to present my comments, although I have little hope that you and your referee will read attentively my objections. But this is my duty as a scientist.

In your letter of the 16 August you write: "At first sight, the content of your paper appears to be in strong disagreement with gauge invariance. Nevertheless, I have given the paper to a referee...". The clue of my paper is exactly that I SHOW theoretically that the gauge invariance leads to WRONG conclusions which CONTRADICT the experimental evidence. According to the gauge invariance concepts, if in two space domains **E** and **B** are equal, then the motion of a test charge in these two space domains must be EXACTLY THE SAME. I show that THIS IS NOT TRUE. The motion of the test charge depends not on **E** and **B** but on Φ and **A**. I give an example where for two space domains with equal **B** the effects demonstrated by the test charges are DIFFERENT because the magnetic potential **A** is different. Thus NOT my paper is to be rejected as wrong but the conventional gauge invariance theory is to be discarded as wrong. This is the purpose of my paper.

Now to the referee's comments. The first objection of the referee is "Your electromagnetic theory is wrong". The referee HAS THE DUTY TO SHOW where my theory is wrong, i.e., where it leads to a contradiction with some experiment, as the criterion for a wrong theory is ONLY ONE: a contradiction with some experiment.

From my side I assert that the conventional gauge invariance concepts are wrong and I show that they lead to a contradiction with experiments.

The referee asserts that the effects predicted by me are due only to the fact that I consider the induction effects in an infinitely long solenoid. I take infinitely long solenoids only to make the calculations simple. One can take short solenoids or even a single loop of the form shown in fig. 1. The effects predicted by me remain the same. My experiment for measuring the Earth's absolute velocity with an electromagnetic set up was done with a very short solenoid, practically with a rectangular loop with small width and a large length. This experiment is reported in the paper

ACTION OF CONSTANT ELECTRIC CURRENT ON ELECTRONS AT REST
DUE TO THE ABSOLUTE VELOCITY OF THE EARTH,

which I submit now to your journal.

My theory predicts the effects observed by me. Thus my theory is right. Conventional theory CANNOT predict these effects. Consequently conventional theory must be discarded. If the referee wishes to save conventional theory, he must show:

1. Either that my experiment is badly done.

2. Or that conventional theory can explain the effects observed.

If the referee can do neither the first nor the second, he has not the right to reject my paper.

I should suggest to you that you publish BOTH my papers, the rejected one and the new one. I send these two papers in SINGLE copies.

Hoping to receive your acknowledgement for the reception of this letter and then in due time also your final decision,

Sincerely yours,

Stefan Marinov

Subscription and administration:
12 Clarence Road,
Kew,
Surrey,
TW9 3NL,
England.

Editor: Professor Alan L. Mackay, FRS
Department of Crystallography,
Birkbeck College (University of London),
Malet Street,
London WC1E 7HX,
England.

SPECULATIONS IN SCIENCE AND TECHNOLOGY

Dr. Stefan Marinov,
Morellenfeldgasse 16,
A-8010 Graz,
Austria.

Fax 01-436 8918

23 August 1989

Dear Dr. Marinov,

Many thanks for your letters. I think that you make thorns for yourself by not conforming more to the current standards for scientific papers. Your books of letters show the surprising tolerance of the scientific community. I have wondered for a long time about your two papers because they appear to contain reports of significant experiments. I think that if you clearly described the experiments so that anyone else could repeat them, leaving out the polemics, and separating the experiment from the deductions, then a journal should be willing to publish them. Can you not be a wolf in sheep's clothing for the sake of the ultimate objective.

As things stand, and in view of my comments in my earlier letter to you, (about throw-away lines assuming non-conservation of energy and perpetual motion machines which discredit the rest of the material), I am unwilling to publish the papers.

Yours sincerely,

A.L. Mackay

Editorial note. With the above letter Dr. Mackay answers Marinov's letter of the 5 August (not published in TWT).
Marinov gives an answer to the above letter with his own of 28 August.

STEFAN MARINOV
Morellenfeldgasse 16
A-8010 GRAZ — AUSTRIA

24 августа 1989 г.

Г-ну Виталию Коротичу
/или дежурному редактору/
ОГОНЕК
Бумажный проезд 14
Москва 101456 ГСП

Уважаемый Господин Коротич!

ОГОНЬКУ начали писать уже многие люди. Многие хотят воспользоваться этим рупором гласности, чтобы рассказать о своем, о чужом или о всенародном горе. Я знаю, что у ОГОНЬКА считанные страницы и я не стал бы отнимать страницы у тех, которые, наверное, больше в них нуждаются. Но то, что хочу сообщить, является делом огромной важности. Надеюсь, что ОГОНЕК даст возможность, чтобы моя информация получила гласность.

Если было бы необходимо, для быстрого осуществления этой публикации и для лучшего ее оформления, я готов в любой момент вылететь в Москву. Мы заинтересованы в возможно скорейшем показе нашего фильма по московскому телевидению.

Я составил не очень большую статью. Если Вы сочтете необходимым, могу ее расширить и увеличить число фотографий.

Я пошлю Вам фотографии, если статья будет принята к печати только при Вашем обязательстве возвращения фотографий. Я мог бы, как уже сказал, и сам принести фотографии и присутствовать при наборе статьи. Я использую эту мою поездку, чтобы посетить Сахарова и Академию Наук.

У меня в Москве "связное лицо" по этому вопросу. Это д-р Сергей Григорьевич Панкратов, редактор отдела физики в журнале НАУКА И ЖИЗНЬ. Прошу Вас, не давайте мне совета отпечатать эту статью в НАУКЕ И ЖИЗНИ. Два года как там лежит моя статья о нарушениях законов сохранения, но академик Гинзбург ее "зарезал" и д-р Панкратов бессилен "протащить" ее. Адрес Панкратова:

Д-р С. Г. Панкратов, журнал НАУКА И ЖИЗНЬ, ул. Кирова 24, Москва - Центр, т. 928-5333.

Очень удобно звонить ему дома /до одиннадцати-двенадцати/ на т. 243-0381.

У д-ра Панкратова находятся все шесть томов моих книг ТЕРНОВЫЙ ПУТЬ ИСТИНЫ.

Я посылаю Вам только том пятый, который почти полностью посвящен машине ТЕСТАТИКА.

Это письмо принесет в Москву и опустить в ящик д-р Владимир Бержатый, пр. Циолковского 7/,-2-44, город Калининград, Московская область, т. 511-437. Д-р Бержатый работает в объединении по космическим исследованиям ЭНЕРГИЯ и находится в Граце на совместном советско-австрийском заседании. Он тоже интересуется машиной ТЕСТАТИКА и может кое-что Вам рассказать. Но гораздо больше знает Панкратов.

После того как приложенная книга Вам больше нужной не будет /и в случае, что статья не будет опубликованной/, прошу Вас вернуть ее мне. Каждый экземпляр этой книги очень дорог.

Номер моего ТЕЛЕФАКСА: Австрия 0316/827560 /телефон для связи: 0316/830063/.

Прошу Вас послать мне ответ о принятии/неприятии либо телеграммой либо телефаксом, с указанием номера Вашего телефакса для возможного быстрого контакта.

Хорошо опубликовать статью с двумя фотографиями.

Моя статья на стр. 36 вышла точно в этом виде в немецком журнале РАУМ УНД ЦАЙТ.

В ожидании Вашего ответа,

Искренне Ваш:

С. Маринов

Стефан Маринов

Editorial note. The above letter remained unanswered. I met Dr. Berzhaty at the first days of November in Vienna and he told me that he has posted the letter to V. Korotich. When I said that there is no answer, Dr. Berzhaty said: "У Коротича теперь земля под ногами горит." - Thus, обождем, чтоб перегорела.

МАШИНА ТЕСТАТИКА И КОММУНА МЕТЕРНИТА

В деревне Линден, в Швейцарии, в тридцати километрах к югу от города Берна, находится христианская коммуна МЕТЕРНИТА. Читателям в Советском Союзе это может показаться маловероятным, но в этой коммуне, которой уже сорок лет, денег нет, иерархии нет, и все живут по принципу "один за всех, все за одного". Каждый трудится согласно своим способностям и получает согласно своим потребностям. Конечно, нужно особо отметить, что члены коммуны не очень требовательны и довольствуются самым необходимым, считая роскошь накопление вещей и расточительство не только не необходимыми, но сугубо вредными для человека. Одна из самых не необходимых /читай, вредных/ вещей является зеленый змий.

В Советском союзе долго спорили можно ли построить социализм в одной отдельно взятой стране, не помешают ли тому внешние и внутренние враги и сколько из этих врагов нужно уничтожить, чтобы социализм построить.Коммунары Метерниты ни такими спорами не занимались, ни врагов не уничтожали, а просто взялись за руки и показали, что построить не только социализм, но и коммунизм в одной отдельно взятой деревне среди моря швейцарских банков не такое уж мудреное дело. Нужно только крепко взяться за руки. Вступление в коммуну открыто всякому, и старику и хромому. Члены могут жить в самой деревне или где угодно на нашей планете и говорить на любом языке. Также выход из коммуны свободен всякому в любое время.

Было бы очень интересно рассказать читателям в Советском союзе, как устроена жизнь и быт коммунаров, как они трудятся без надсмоpщиков, без красных и черных досок, без зарплат, как питаются в общей столовой, как устроена общая стирка и починка одежды, каковы их духовные интересы, но для этого нужно было бы написать особую статью.

Я хотел бы здесь рассказать об одной интересной вещи в этой коммуне, особо отмечая, что там есть другие еще более интересные, о которых лучше пока-что помолчать.

Одним из основателей коммуны является простой швейцарский крестьянин, Пауль Бауманн, который еще подростком до второй мировой войны был отдан отцом в батраки к зажиточному крестьянину и поэтому ходить в школу и учиться он не мог. К большому удивлению своего хозяина Пауль, повозившись с давно не идущими часами, пустил их в ход, потом починил утюг, потом сельско-хозяйственую машину, которая, как безнадежно испорченная, была заброшена. А раз злейший пес в деревне сорвался с цепи и побежал по улицам. Испуганные жители поспешили скрыться по своим домам, тогда как Пауль, без всякого испуга, подошел ко псу, погладил его по голове и пес прилег у его ног. С того дня и зашептали крестьяне что маленький Пауль /а он был и очень низкого роста/ околдован нечистой силой. Паулю сегодня 70 лет, но по сей день не темные крестьяне в заброшенной в Альпах деревни, а швейцарская бульварная пресса продолжает распространять, как это ни странно, ту же самую небылицу.

Только пару лет как Пауль и другие люди, верившие в возможность человеческого братства и взаимной любви, организовали коммуну, железный кулак государственной машины обрушился на нее. Сорок хорошо вооруженных полицейских ворвались ранним утром в коммуну, переворошили все дома и арестовали многих из коммунаров. Этот первый раз государство не успело состряпать процесс и скоро все арестованные были освобождены. Однако через пару лет акция была подготовлена получше и по фальшивому обвинению Пауль был осужден на семь лет. Для государства эта коммуна была не приемлемой, так как коммунары были не поданными, а свободными, независимыми и неуправляемыми людьми. Если бы все деревни в Швейцарии стали бы такими коммунами, то негде было бы нанимать чиновников для банков и полицейских,и государство просто умерло бы.

Так как директор тюрьмы был почтенным человеком и поведение Пауля было безупречным, он отсидел "от звонка до звонка" только четыре года и был раньше своего срока освобожден. Вопреки ожиданиям душителей коммуны, она все это время просуществовала и поддерживала вся того одного, который томился в тюрьме.

В тюрьме была мастерская, где Пауль работал. И вот в этой мастерской он построил первые две машины ТЕСТАТИКА, которые движутся без всяких источников энергии и производят в изобилии так называемую "свободную энергию", т.е. создают энергию из ничего. Иными словами машина ТЕСТАТИКА является не только вечным двигателем /перпетуум мобиле/, но и вечным генератором. Эти первые построенные в тюрьме машины были с одним колесом /они видны на обложке моей книги TWT-V ина страницах 30, 31 и 51 /верхний снимок//. После выхода из тюрьмы Пауль построил машины с двумя противоположно вращающимися колесами /они видны на страницах 4, 27, 33, 34 и 51 /нижний снимок//, где бо́льший выход свободной энергии /двухколесная машина производит 3 киловатт свободной энергии в виде прямого тока силой в 10 ампер под напряжением300 вольт/.

Машина ТЕСТАТИКА электростатическая и имеет много общего с инфлюенчными генераторами типа Теплера-Гольтца-Вимшерста и с электростатическими моторами типа Гольтца - Поггендорфа-Грюеля, которые были построены во второй половине девятнадцатого века и являются, так сказать, детьми электростатических машин Бенджамина Франклина из восемнадцатого века.

У машины ТЕСТАТИКА нет никаких трущихся контактов, но электроды находятся на очень близком расстоянии от поверхностей вращающихся металлических сегментов. Конденсаторы, куда "накачиваются" электрические заряды и откуда они "снимаются" для совершения нужной нам работы, имеют особую конструкцию. Я не разобрался полностью в принципе ее действия, но думаю, что суть этой странной машины, опровергающей закон сохранения энергии, закон в котором все сегодняшние физики слепо верят, состоит в том, что механическое сопротивление инфлюенчного генератора зависит не от накачиваемой в конденсатор электрической мощности, а только от его напряжения и если накачивать при низком напряжении конденсатор с большой емкостью /ниже 300 - 400 вольт/, то единственное механическое сопротивление, которое нужно преодолевать, является трение в шарикоподшипниках колеса.

Коммунары не хотят эту машину патентировать и потом "продавать", так как они деньги презирают. Они боятся, что человечество, которое живет с неправильными представлениями о том, что такое хорошо и что такое плохо, будет использовать этот абсолютно чистый и бездонный источник энергии с таким безразсудством, с каким оно использует все ему доступные теперь источники энергии.

За эти 10 лет как первые прототипы машины построены, ТЕСТАТИКУ видели возможно не одна тысяча человек. Слух о ней известен вомногих кругах по всему миру и разные люди пытаются вникнуть в ее секрет и ее построить. Машина очень проста, как это и видно из фотографий, и если не сегодня, то завтра кому-нибудь удастся эту машину построить.

Я являюсь членом коммуны и выступил с мнением, что пора оповестить миру открыто о существовании этой машины. Так как коммунары самого плохого мнения о западных учеых и о западной прессе /они от этих ученых и от этой прессы кроме клевет, насмешек и ругани ничего другого не получали/, то я им предложил обратиться к академику Сахарову и к Академии Наук СССР. Моральная чистота Сахарова и ошеломляющее духовное возрождение в Советском союзе являются лучшим залогом, что оповещение миру о великом открытии совершится с соответствующей серьезностью и смирением перед удивительной природой.

Мы изготовили сорока-минутный фильм, посвященный машине и нашей коммуне, который кончается призывом ко всему человечеству проклясть военщину и милитаризм, жадность к власти, к деньгам, к накоплению и к расхищению. Я обратился к Сахарову, с которым я лично знаком и два раза /в 1978 и1987 годах/ у которого бывал, и к Президенту Академии Марчуку с письмами, чтобы они посетили нашу коммуну лично или послали доверенных им лиц, чтобы убедиться, что машина является вечным гетератором. Если они убедятся, то чтобы потом показать наш фильм по московскому телевидению с ихним коротким вступительным словом.

Уже три месяца прошло, как я эти письма послал, но никакого ответа ни от Сахарова, ни от Марчука не получил. На мои дополнитальные письма также нет никакого ответа. Мое обращение и личное посещение в советские посольства в Вене и в Берне также ни к каким результатам не привели. Я надеюсь, что эта публикация в ОГОНЬКЕ ускорит выработку ответа и не только в Союзе, но по всей земле люди скажут: "ОГОНЕК помог".

uigi DiLella
ditor – in – charge
nt. Journal of Mod. Phys. A
Mod. Phys. Lett. A

Dr. Stefan Marinov
Morellenfeldgasse 16
A – 8010 GRAZ
(Autriche)

25 August 1989

ear Dr. Marinov,

I have received your two papers:

The electromagnetic effects are determined ...

Action of constant electric current on electrons at rest ...

hich you have submitted for publication in IJMPA.

As Editor – in – charge for Europe of IJMPA, I am not obliged to waste my time and the time of ferees on your papers. In particular, you cannot pretend that we repeat your experiments to prove at they are wrong. So far, your papers have been carefully read by three independent referees and I ave sent you their comments hoping that they would convince you. Since it is now clear to me that u cannot be convinced, I am using my capacity as Editor – in – charge to reject your papers without ferecing them. In taking this decision, I fully accept the possibility that you may be right and I may wrong. After all, editors of scientific journals are not infallible.

Please feel free to publish the present letter in Volume n + 1 of your book "The Thorny Way to ruth". But I beg you to stop sending me your papers.

Sincerely yours,

L. diLella

Luigi DiLella

STEFAN MARINOV
Morellenfeldgasse 16
A-8010 GRAZ — AUSTRIA

28 August 1989

Dr. Alan Mackay
SST
Birkbeck College
Malet Street
London WclE 7HX

Dear Dr. Mackay,

Thank you very much for your letter of the 23 August although the definite rejection of my two papers "Maxwell's displacement current...." and "Extremely easy experiment.." was, of course, not pleasant for me.

You write that in my papers I have not to write about non-conservation of energy and perpetual motion machines. In my two rejected papers these two words are NOT mentioned. If you have some suspicions, I can send you the papers, and if you can find such words there, I shall pay you 5000£.

In the papers is mentioned the violation of Newton's third law and the violation of the angular momentum conservation law (and possibly of the momentum conservation law). But in any THIRD book on electromagnetism FOR STUDENTS it is written that the Lorentz equation (and the following from it Grassmann's equation) VIOLATE Newton's third law. Thus you wish that I do not mention even THIS which is mentioned in any third textbook of the XX-th century and in ANY textbook of the the second part of the XIX-th century. The only originality which I make is to observe the interaction of loops INTERRUPTED by condensers. There are only TWO MEN who have done similar experiments (Graham and Lahoz, publication in NATURE in 1980) and they have also observed violation of the angular momentum conservation law, although they have wrongly interpreted their OBSERVATION and have assumed that the "opposite" angular momentum is "taken" by the potential electromagnetic field. Whether the opposite momentum has been "taken" by the field is a problem of discussion, however, the rotation of their freely suspended body by internal forces was OBSERVED and the law of momentum and angular momentum conservation say that such a rotation can be NOT observed. That's the whole story.

I think that, as a matter of fact, Graham and Lahoz have followed YOUR advice and they have REPORTED a violation of the angular momentum conservation law but have FALSIFIED their observation, so that their paper can APPEAR. This is not a FAIR play. I write what I have observed and I interpret my results according to my convictions. If people do not wish to learn what have I observed and how I interpret my observation, and if I have to write NOT this what I think, I consider this as UNFAIR. I write my papers not only for the readers of the year 1989 but also for the readers of the year 2989. Better to remain with unpublished paper than with a not fairly written paper.

Now I submit to SST my paper

ACTION OF CONSTANT ELECTRIC CURRENT ON ELECTRONS AT REST
DUE TO THE ABSOLUTE VELOCITY OF THE EARTH.

I beg you to acknowledge the reception of the paper.

Sincerely yours,

Stefan Marinov

PS. If TWT-VI will be of no use for you, please, send the book back to me.

Editorial note. Dr. A. Mackay rejects the above paper with his letter of the 17 October 1989 suggesting that I submit my paper to a "more respectable journal". The letter of Dr. Mackcay is NOT published in this volume for a lack of space.

The above mentioned paper is published in TWT-IV, p. 110.

Annales de l'Institut Henri Poincaré
PHYSIQUE THÉORIQUE • THEORETICAL PHYSICS

Palaiseau, le 31 Août 1989

Prof. S. MARINOV
16 Morellenfeldgasse
A-8010 GRAZ
AUTRICHE

Dear Sir,

The editorial board of the Annales has examined your paper "On the Absolute Aspects of the Electromagnetic Interactions".

The editorial policy is to consider only papers containing theoretical developments in agreement with the ideas quasi universally accepted by the physics community. The editorial board is conscious that this policy may eventually lead to the rejection of papers containing deep and original results. The board has however decided once for all to follow this policy.

We regret that, on this grounds, we cannot accept your paper for publication in the Annales.

Sincerely yours,

P. COLLET.

Editorial note. The above mentioned paper is published in TWT-II, p. 329.

gauthier-villars

Publié avec le concours du CNRS.

Helvetica Physica Acta

OFFICE OF THE EDITOR
EPFL Institut de physique théorique

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Telex 454 478

Dr. Stefan Marinov
Morellenfeldgasse 16

A-8010 Graz
Austria

Lausanne, September 5, 1989

Dear Dr. Marinov,

I regret to inform you that your paper "Violation of the laws..." has not been found suited for publication in Helv. Phys. Acta. Although it is legitimate to question an accepted theory, your strong assertion that electromagnetism is "wrong in many aspects" should be more deeply founded and motivated, especially in the light of modern atomic and molecular physics including quantum mechanical effects. On the contrary, there are evidences for the full validity of electromagnetism at all observational levels.

Thanking you for your interest in our Journal, I remain,

Sincerely yours,

Ph. A. Martin
Editor

Editorial note. In his letter of the 5 August, with which Marinov submitted the paper "Violations of the laws of conservation of angular momentum and energy" (published in TWT-III, p. 33) to HELVETICA PHYSICA ACTA, Marinov gave expression of his astonishment that Swiss physicists have not visited, examined and recognized the first perpetuum mobile on our planet, the machine TESTATIKA, constructed 10 years ago in SWITZERLAND. Marinov sent with his 5-August-letter abundant information on TESTATIKA to Dr. Martin. As the reader can see, in the above letter Dr. Martin does not mention even with a single word the wonder discovered in the village Linden, which is only 30 km far from Bern.

Marinov answers the above letter with his letter of the 9 September.

STEFAN MARINOV
Morellenfeldgasse 16
A-8010 GRAZ — AUSTRIA

Dr. Ph. A. Martin
HELVETICA PHYSICA ACTA
Inst. de physique teorique
PHB-Ecublens
CH-1015 Lausanne

9 September 1989

Dear Dr. Martin,

Thank you very much for your letter of the 5 September, although, I must confess, the rejection of my paper "Violation of the laws..." was, of course, not pleasant for me.

In your comments you write:

> ...your strong assertion that electromagnetism is "wrong in many aspects" should be more deeply founded and motivated, especially in the light of modern atomic and molecular physics including quantum mechanical effects. On the contrary, there are evidences for the full validity of electromagnetism at all observational levels.

Conventional electromagnetism asserts that the electromagnetic potentials are "unobservable quantities" and only the electric and magnetic intensities are "observable" quantities. Consequently conventional electromagnetism introduces the gauge invariance concepts, according to which one can change the electromagnetic potentials to a certain extent, making them different from those defined by the Coulomb and Neumann laws (the notion NEUMANN LAW is introduced by me for the magnetic energy of two charges q, q' moving with velocities **v**, **v**' at a distance r between them

$$W = qq'\mathbf{v}.\mathbf{v}'/c^2r).$$

However, it is exactly in quantum mechanics that one observes the so-called Bohm-Aharonov effect which shows that the motion of the particles is determined NOT by the intensities but by the potentials.

I was the first scientist in the world who has shown that the motion of ALL CHARGED PARTICLES (microscopic and macroscopic) is determined NOT by the intensities but by the potentials. I DISCOVERED the motional-transformer induction, i.e., I showed by theory and experiments that if a magnet generating the magnetic potential **A** at a certain reference point moves with a velocity **v**, then the electric intensity induced in a piece of metal at rest at the reference point is

$$E_{mot-tr} = (\mathbf{v}.\mathrm{grad})\mathbf{A}.$$

One does not see in this formula the magnetic intensity **B** = rot**A**. One sees only the magnetic potential **A**. My theory and experiments are CHILDISHLY SIMPLE. The errors of conventional electromagnetism are OBVIOUS. If such a prestigious journal as yours cannot see all this, of course, your only move is to reject my papers without motivated and RELEVANT comments.

I submit now to you my paper

THE ELECTROMAGNETIC EFFECTS ARE DETERMINED BY THE POTENTIALS
AND NOT BY THE INTENSITIES.

If you will accept this paper, I shall be very glad. If you will reject it without presenting MOTIVATED comments, I think, it will be senseless to submit more papers to your journal.

I wonder that you showed NO interest to the FIRST perpetuum mobile on this planet which was constructed in SWITZERLAND. This is an electromagnetic machine and it is presented in the V-th volume of my series THE THORNY WAY OF TRUTH. On the 28 and 29 October there will be a big Congress on FREE ENERGY in Einsiedeln. You and other collaborators of your journal and Institute are warmly welcome to attend the congress. I will be there with a couple of other members of the community METHERNITHA and a 40-minutes film on TESTATIKA will be presented. For more detail on the congress, you can address, IN MY NAME, the organizer: Peter Engeler, SAFE, Postfach 402, CH-8840, Einsiedeln.

Hoping to receive your acknowledgement for the reception of my paper and then in due time also your final decision,

Sincerely yours, S. Marinov

Stefan Marinov

Editorial note. Dr. Martin answers the above letter with his own of 26 September.

PHYSICAL SOCIETY OF JAPAN
Kikai-Shinko Building, 3-5-8 Shiba-Koen, Minato-ku
Tokyo 105, Japan

September 11, 1989

Dear Dr. Stefan Marinov
Institute for Fundamental
Physics,
Morellenfeldgasse 16,
A-8010 Graz,
Austria

Dear Dr. Marinov:

Your two manuscripts

#1032 entitled "Extremely Easy Experiment Demonstrating Violation of the Angular Momentum Conservation Law" and

#1033 entitled "Propulsive and Rotating Ampere Bridges Violate the Energy Conservation Law"

were examined by a referee. His judgement is that your two manuscripts are not appropriate for publication in our Journal. Referee's comments are enclosed herewith.

We are returning your manuscripts to you.

Sincerely yours,

Taizo Masumi
Editor-in-Chief
Journal of the Physical
Society of Japan

Editorial note. Marinov answers this letter with his letter of the 13 October.

この"著者に対する注意"はこのまま複写して著者に送らせていただきますので御了承下さい。尚，複写を希望されない場合はその旨お申し出下さい。

Journal

著者に対する注意

All the electromagnetic phenomena are completely described by the Maxwell equations together with the Lorentz equation (or by the quantized form, if necessary), which guarantee the conservation of momentum and angular momentum. Ampere's formula as well as Grassmann's one, on which this paper is based, are nothing more than the approximate form of the Maxwell equations.

PHYSICS LETTERS A

OFESSOR J. P. VIGIER
iversité Pierre et Marie Curie
ntre National de la Recherche Scientifique
boratoire de Physique Théorique
stitut Henri Poincaré
Rue Pierre et Marie Curie
231 Paris Cedex 05
ance
lephone (14) 336 2525 ext. 3776/82
lex: UPMC Six 200 145 F

12/9/89 12 September 1989

V726a*/V727a/
V791a/V792a

Dear Dr Marinov

The responses of the referee(s) to your papers is negative (copy(ies) enclosed). I regret that I am unable to accept your paper for publication ~~and return your manuscript~~ herewith.

Yours sincerely,

Vigier

J.P. VIGIER

* V726a has already appeared in print in 'The Thorny Way of Truth' part I — it is not the policy of PLA to republish works which have already appeared.

Editorial note. Marinov answers the above letter with his letter of the 9 October.

NORTH-HOLLAND PHYSICS PUBLISHING ★ P.O.B. 103 ★ 1000 AC AMSTERDAM ★ THE NETHERLANDS
Cables: ESPOM Amsterdam — Telex: 10704 espom nl — Telephone: 020 - 586 29 11

PHYSICS LETTERS A
Ref. Nr. V 791a

referee report on revised manuscript
"The Absolute and Relative Newton-Lorentz Equations"
by S. Marinov

The author derives two formulas for electric field,

$$\underline{E}_1 = \underline{v} \times (\underline{\nabla} \times \underline{A})$$

and

$$\underline{E}_2 = (\underline{v} \cdot \underline{\nabla}) \underline{A}$$

He claims that these are numerically different. But the vector identity

$$\underline{a} \times (\underline{b} \times \underline{c}) = (\underline{a}.\underline{c})\underline{b} - (\underline{b}.\underline{a})\underline{c}$$

converts $\underline{E}$/1\ to

$$(\underline{v}.\underline{A}) \underline{\nabla} - (\underline{\nabla}.\underline{v}) \underline{A}$$

Only the second term is meaningful as an $\underline{E}$ field, and it reduces to just $\underline{E}$/2\.

The author also claims that conventional physics does not recognize the second formula, which describes the situation where vector potential depends on time via the changing positions of the sources producing the potential. But the conventional formula for electric field in MKS units is

$$\underline{E} = - \underline{\nabla} \phi - \frac{\partial \underline{A}}{\partial t}$$

and there is no qualifier limiting the possible causes for time change in $\underline{A}$.

The author is however right about some things. There is a conflict between the unobservability of potentials in classical electromagnetics and the central role of potentials in the Aharonov-Bohm effect and in quantum mechanics generally. Problems do get swept under the rug in textbooks. And a modernized ether really is good for something. But he so overtates* the case that publishing his diatribe could only cause even deeper entrenchment of established prejudices.

* overtakes

PHYSICS LETTERS A
Ref. Nr. V727a

Referee's 2nd report on "Extremely Easy Experiment Demonstrating Violation of the Angular Momentum Conservation Law" by S. Marinov

This paper has two parts: one theoretical and one experimental. In the former Marinov compares Grassmann's and Ampere's formulas for the force between two current elements. He notes that whereas Ampere's law conforms to Newton's third law, Grassmann's does not.

The whole theoretical section (up to the middle of p. 3) is really just a preamble. This is because Marinov's first reply and my first report concur in the observation that the two formulas cannot be distinguished on the basis of present experiments. These experiments include observation of the force which one complete current loop exerts on another and measurement of the force which a complete loop exerts <u>on</u> an element in another.

This reader, in any event, would be happiest to see the theoretical section deleted. It confused me by making me believe that Marinov's experiments were going to distinguish between Grassmann's and Ampere's formulas. As Marinov correctly noted in his reply the confusion was all mine. Nonetheless it does seem misleading to spend so much time on the theory only to say that Grassmann must be right, which is what all the contemporary textbooks assume anyway. Deleting the theory would leave more room for the author's experiments which I believe are the critical part of his work.

What of the author's own experiments?

There are five of these discussed in the present paper:

a) the Bul Cub machine without stator (p.3)

b) the historical Ampere bridge (p.4)

c) the historical bridge with the central current element twisted (p.4)

d) The displacement current bridge (or flying Ampere bridge) (p.4)

e) The rotating Ampere's bridge (p.5 and fig 4).

Positive effects are obtained in all experiments. The experiments are not equivalent, however. Experiments b and c employ only metalic conductors. The author is not offering the dramatic positive effects from these nineteenth century experiments as evidence for momentum non-conservation. In contrast some part of experiments a, d, and e is open; ie. part of the circuit is a capacitor, ideally devoid of dielectric. When a current flows, conventional theory allows the vacuum of the capacitor to absorb energy and momentum. Marinov, however, does not believe that the vacuum can do this. Hence he interprets his experiments (and that of Graham and Lahoz) as evidence for violation of conservation of momentum.

In my first report I asked 4 questions to help me better understand Marinov's rotating Ampere bridge experiment. Unfortunately none of the answers was very helpful. I asked, "What does conventional theory predict". What I expected were details concerning the apparatus under the (conventional) assumption that the vacuum can store energy. Such details include a numerical comparison of the predicted and measured torques on the rotor.

I asked how the author's apparatus differs from that of Graham and Lahoz. This is a very important question. I do not see how any of the author's experiments a, d or e is fundamentally different from G and L's. I would very much appreciate a description of a hypothesis which is untestable by G and L but which is testable by one of the author's experiments.

Finally I asked a detailed question concerning the flow of currents in fig 4. Even the author's detailed reply does not help much. Here it would be so simple just to add arrows to the figure itself.

The author may rightly sense that I believe his description of the rotating Ampere bridge experiment is inadequate. This may be because he is trying to describe too many experiments in a short paper.

I suggest that the author concentrate on giving a complete technical description of (e) and forget about the others. In rewriting this section I suggest the author concentrate on my earlier questions. To these he might add another question:

Is the use of dielectric in the capacitor justifiable?

Admittedly it is convenient to use barium titanate as a dielectric. Having a dielectric constant of 10,000, this substance permits a given apparatus to handle roughly 10,000 times the current that a vacuum capacitor could handle. But the use of dielectric seems an unjustifiable way to make detectable an effect which otherwise would be quite small. This is because the currents in barium titanate are polarization currents and thus involve explicitly the movement of charge. Thus such currents are comparable to ordinary conduction currents rather than the aethereal displacement currents in vacuo, which are the author's main concern.

Alternatively, the author may wish to write a short paper which gives his interpretation of the G and L experiment. This could be done separately from documenting his own experiments.

Canadian Journal of Physics
Journal canadien de physique

September 19, 1989

Dr. Stefan Marinov
Morellenfeldgasse 16
A-8010 Graz, AUSTRIA

Dear Dr. Marinov:

Re: GR-113 entitled "The Absolute and Relative Newton-Lorentz Equations."

GR-114 entitled "Maxwell's displacement current does not generate magnetic field."

I have received a letter from the referee to whom we sent your papers for review on August 8th.

The referee reports that he has seen the GR-114 (Maxwell's displacement current) paper before. It was sent to him for review by the editor of Physics Letters.

It is a breach of professional ethics to send the same paper to two journals at the same time. The whole publication system depends on the good will of unpaid editors and referees who devote time to the publication system which they may well feel better used on their own research. When an author takes unfair advantage of the system as you have done, referees (and editors) feel very annoyed at having been "used."

Normally we do not ask authors to give us written assurance that their papers have not been sent simultaneously elsewhere as we rely on people's honesty not to do this.

I regret that we cannot now consider GR-114 and I return the manuscript herewith. If you can give me a written undertaking that GR-113 has not been submitted elsewhere, the referee is prepared to review it.

Yours truly

Ralph Nicholls

R.W. Nicholls
Editor
encl.

Editorial note. Marinov answers the above letter with hi[s] own of 6 October.

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Dr. Stefan Marinov
Morellenfeldgasse 16

A-8010 Graz
Austria

Lausanne, September 26, 1989

Dear Dr. Marinov,

I acknowledge receipt of your letter of September 9, 1989 and the enclosed paper, and I regret to inform you that we cannot accept it for publication for the same reasons as previously given to you.

As you may know, gauge invariance is recognized as a building block of present days quantum field theory including electromagnetism and elementary particles theories.

Any claim to abandon gauge invariance should be deeply motivated by a thorough discussion of all consequences, including atomic and particle physics as well.

This is completely missing in your paper, which therefore is without interest for our Journal.

Sincerely yours,

Ph. A. Martin
Editor

CZECHOSLOVAK JOURNAL OF PHYSICS
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Na Slovance 2, 180 40 Praha 8, Czechoslovakia

Dr. Stefan Marinov
Morellenfeldgasse 16
A-8010 Graz
Austria

3. 10. 1989

Dear Dr. Marinov,

I write about your paper "Action of constant electric current ..." (No. 2952), which we received from you on 5th April, 1989. Thank you for your letter of 30 March.* I appreciate your rather tolerant point of view, but the fact is that your papers have always been a lengthy matter in our office and I am not sure that the result has always been to your satisfaction. I therefore decided to pass your paper to a referee abroad. Unfortunately, the referee did not reply till now nor did he sent a report although four and half months have passed since my sending him your paper. As a result, I have till now no material to make a decision on your paper.

I could of course send the paper now to some other referee and wait for his reply. But this may take another 4 months or more. I would therefore consider as more appropriate to the situation if you would submit your paper to a specialized relativity-oriented journal. You are aware that our Journl has been mainly focused on solid state physics, plasma physics and, more recently, also on some topics in particle physics, nuclear physics and mathematical physics. But there has been very little relativity. This is in contrast with the fact that in your papers you often touch some very subtle and controversial problems of the theory of relativity, which can hardly receive the proper publicity in our Journal. If you, on the other hand, submit your papers to a relativity-specialized journal, you can be sure that they will receive the adequate recognition and appreciation.

I firmly hope that you will understand the situation and will agree with the latter alternative, i.e., that I send you back your contribution and you will submit it to a specialized journal.

Yours sincerely,

J. Fischer
J. Fischer
Editor

*See TWT-V, p. 300. Ed. note. Answer on p. 287.

STEFAN MARINOV
Morellenfeldgasse 16
A-8010 GRAZ — AUSTRIA

6 October 1989

Dr. R. W. Nicholls
Canadian Journal of Physics
Deptm. of Physics
York University
4700 Keele Street
North York
Ontario M3J 1P3

Dear Dr. Nicolls,

Thank you very much for your letter of the 19 September 1989 concerning my papers GR-113 and GR-114.

It is true that my paper GR-114 was submitted to PHYSICS LETTERS. But this was A YEAR AGO. The paper was rejected by the editor J. P. Vigier, although I submitted objections to the referee's report which showed that there was neither a single tenable criticism in the referee's comments. I enclose my letter to Prof. Vigier of the 23 November 1988 and the presented objections. I think, it is not necessary to send you also the referee's comments, as ALL his comments are CITED in my objections! If you will ATTENTIVELY read my objections to the referee's criticism, you will see that the referee (and Prof. Vigier) HAD NOT THE RIGHT to reject my paper. Nevertheless, the paper was rejected and the referee did not present COUNTER-objections to my objections. My logic is such a one that it was impossible for the referee to present counter-objections. This is the case with ALL referees of ALL physical journals during the last 20 years.

Thus because my paper GR-114 is until now not published, the scientific community continues to think that displacement (and polarization) current does generate magnetic field and to teach this LIE to the students in the colleges and the universities. And the scientific community still believes that Bartlett and Corle have measured the magnetic field of the displacement current "flowing" between the plates of a condenser (meanwhile between the plates of a condenser flows NOTHING).

I send you again my paper. I think that you have to ask your (and the PHYSICS LETTERS referee) to answer my objections to his UNTENABLE criticism. And you have to reject my paper only if this referee will present such objections. I hardly believe that he will do this. Thus you have to take into account this FACT and without searching for the opinion of another referee you have to publish my paper. If your (and the PHYSICS LETTERS) referee will present counter-objections to my objections I beg you to send them to me. I repeat, however, I put 100 to 1 that he will NOT do this.

Concerning the paper GR-113 I have to tell you the following. The paper IS submitted to another journal but long time I have no answer (this is the case with 80% of my submitted papers). I am sure that the paper either will be rejected or I shall not receive an answer at all. Thus you can either await until the paper will be rejected (I shall inform you about) or send the paper back to me. Do as you like.

Thus at the moment being I expect your decision only on my paper GR-114

MAXWELL'S DISPLACEMENT CURRENT DOES NOT GENERATE MAGNETIC FIELD.

I send you the copy of the paper which you sent to me back with your letter.

Please, be so kind to acknowledge the reception of this letter and then to send me your final decision on the paper.

Sincerely yours,

S. Marinov

Stefan Marinov

Editorial note. This letter remained without answer.

PS. Let me note that my paper GR-113 was submitted on the 24 November 1988 and you acknowledged its RECEPTION with your letter of the 8 August 1989. An editor has not the right to request a fair attitude of the authors if he has not a fair attitude to them. How can I know that my paper is under examination if the acknowledgement for reception comes 8 MONTHS after the submission!!!!!

STEFAN MARINOV
Morellenfeldgasse 16
A-8010 GRAZ — AUSTRIA

Prof. J. P. Vigier
PHYSICS LETTERS A
Institut H. Poincare
11 Rue Pierre et Marie Curie
F-75231 Paris Cedex 05

9 October 1989

Dear Prof. Vigier,

Thank you very much for your letter of the 12 September which I answer with a certain delay as I was abroad.

I do not accept the referee's criticism on my papers V727a and V791a and I give my CATEGORICAL OBJECTIONS. Thus I beg you to reconsider these papers in the light of my objections and to write me AS SOON AS POSSIBLE whether you, even having my objections, will decide for a DEFINITE rejection of my papers. Now I do not ask more for additional referee's opinions. I ask only for a DEFINITE rejection. After such a DEFINITE rejection I shall submit my papers to another journal. As these papers have been in your hands VERY LONG TIME, I beg you to send me the answer in the shortes possible time.

My paper V726a was published in TWT-I, third edition,AFTER having been submitted to PHYSICS LETTERS A. Your journal is for RAPID publications but you examine my papers unadequately long time. In this way you (as all other editors of the physical journals in the world) block the communication of EXTREMELY IMPORTANT experiments which show the way for constructing perpetual motion machines. I submitted my machines for patents but my applications have been returned with the motivation that my machines work AGAINST THE PHYSICAL LAWS which are taught in the Austrian universities. I am afraid that my experiments which are in the hands of TOO MANY REFEREES can be simply STOLEN. To preserve my priority I must publish them in the series THE THORNY WAY OF TRUTH which has an extremely limited circulation. If you reject my paper V726a, after having examined it MORE THAN A YEAR, with the motivation that it has been published in TWT-I, you simply BLOCK an extremely important scientific information and lies and stupiditeis will be further taught not only in the Austrian but in ALL universities of the world, and the patents will be not accepted, and there will be a VICIOUS CIRCLE. This circle can be broken ONLY BY PUBLICATION of my papers. Thus I insist that you PUBLISH the paper V626a and I beg you in your answer to give me a DEFINITE decision about its rejection (or acceptance), so that I can submit the paper to another journal.

My paper V792a is extremely important. As I have no the intension to lose my time by arguing with the referee, I withdraw the paper and I shall submit it to another journal.

Thus I am expecting your FINAL DEFINITE DECISION on my papers:

V727a: EXTREMELY EASY EXPERIMENT DEMONSTRATING VIOLATION OF THE ANGULAR MOMENTUM CONSERVATION LAW.

V791a: ABSOLUTE AND RELATIVE NEWTON-LORENTZ EQUATIONS.

V726a: MAXWELL'S DISPLACEMENT CURRENT DOES NOT GENERATE MAGNETIC FIELD.

Now I submit to PHYSICS LETTERS A my paper (sent in a single copy):

THE DEMONSTRATIONAL MOLLER-MARINOV MACHINE.

The PACS numbers are 03.50 and 41.10.

All eventual charges will be paid by myself.

Herewith I transfer the copyright for this paper to PHYSICS LETTERS A.

Hoping to receive your answer VERY SOON,

Sincerely yours,
S. Marinov
Stefan Marinov

Editorial note. Prof. Vigier has answered the above letter with his letter of the 30 November 1989.

OBJECTIONS OF STEFAN MARINOV TO THE SECOND REFEREE'S COMMENTS
ON MARINOV'S PAPER "ABSOLUTE AND RELATIVE NEWTON-LORENTZ EQUATIONS"
V791a

The referee has entitled his second comments on my paper as follows:

Referee report on revised manuscript...

The referee is WRONG. I have NOT submitted a revised manuscript. The referee has in his hands ONE AND ONLY ONE manuscript.

The referee writes in his comments the following mathematical relation

$$\mathbf{v}\times(\nabla\times\mathbf{A}) = (\mathbf{v}.\mathbf{A})\nabla - (\nabla.\mathbf{v})\mathbf{A},$$

where $\mathbf{v}$ and $\mathbf{A}$ are two arbitrary vectors.

The above formula is an IDIOTIC formula and when my students write such IDIOTISMS, I give them bad notes and I do not let go them through until the day when they begin to write the formulas of vector analysis well.

According to the rules of vector analysis the left side of the above relation can be presented as follows

$$\mathbf{v}\times\mathrm{rot}\mathbf{A} = \mathrm{grad}(\mathbf{v}.\mathbf{A}) - (\mathbf{v}.\mathrm{grad})\mathbf{A} - (\mathbf{A}.\mathrm{grad})\mathbf{v} - \mathbf{A}\times\mathrm{rot}\mathbf{v},$$

and for $\mathbf{v}$ = **Const**, as it is when $\mathbf{v}$ is the velocity of a test charge (and $\mathbf{A}$ is the magnetic potential generated at the reference point crossed by the test charge), we obtain

$$\mathbf{v}\times\mathrm{rot}\mathbf{A} = \mathrm{grad}(\mathbf{v}.\mathbf{A}) - (\mathbf{v}.\mathrm{grad})\mathbf{A}.$$

A referee who cannot operate with the formulas of vector analysis must be immediately DISQUALIFIED and the Editor has NO MORE to search for his help. To send papers for review to referees who do not know basic mathematics is the same crime as to give a scalpel in the hands of a man who does not know human anatomy.

Maybe, reading the referee's report,the Editor has not noticed that his referee has written a mathematical idiotism (one is tired, there are too many referee's reports, etc.) But if, after reading my present objections, the Editor will not realize that his referee is a MATHEMATICAL INVALID, then one has also to DISQUALIFY THE EDITOR.

I should like to read the comments of the Editor of PHYSICS LETTERS A to my above statements and I should like to learn whether he agrees with me or not.

Thus I beg the Editor either to present a negative referee report on my paper written by a qualified person (the Editor surely has some students with good notes in mathematics) or TO ACCEPT my paper for publication.

As I have disqualifies my present referee,I DO NOT ALLOW other my papers to be sent to him for opinion.

OBJECTIONS OF STEFAN MARINOV TO THE SECOND REFEREE'S COMMENTS ON MARINOV'S PAPER "EXTREMELY EASY EXPERIMENT DEMONSTRATING VIOLATION OF ANGULAR MOMENTUM CONSERVATION LAW" - V 727a

I presented a very detailed answer to the first referee's comments. In my first comments I showed that the referee is not acquainted with the present status of the Grassmann-Ampere controversy. Instead to recognize his incompetence, now the referee writes:

> This reader (i.e., the referee himself - S.M.), in any event, would be happiest to see the theoretical section deleted. It confused me by making me believe that Marinov's experiments were going to distinguish between Grassmann's and Ampere's formulas. As Marinov correctly noted in his reply the confusion was all mine. Nonetheless it does seem mesleading to spend so much time on the theory only to say that Grassmann must be right, which is what all the contemporary textbooks assume anyway.

I have to repeat again and again that in only ONE OF SEVENTY contemporary textbooks can one find Grassmann's formula, because when some professor will write this formula in a textbook, he has immediately to recognize that this formula VIOLATES NEWTON'S THIRD LAW. And ANY writer EVADES to mention this formula and the UNPLEASANT conclusion to which it leads. It is true that any student who has in his hands the Lorentz equation (which can be found in ANY textbook!!!) can immediately DEDUCE Grassmann's formula. But the professors ARE AFRAID TO DO THIS, for the same reason for which small chlidren evade to enter in dark rooms.

I shall give an example how W. T. Scott (The Physics of electricity and magnetism, John Wiley, 1959, 1966) introduces Grassmann's formula (p. 294):

> <u>Problem 7.6a</u>. Show by an example that the forces according to 7.4-2, (i.e..
>
> $$\mathbf{F} = i\int d\mathbf{l}\times\mathbf{B} \quad - \text{ S.M.})$$
>
> and 7.6-3 (i.e.,
>
> $$d\mathbf{B} = \mu_0 i d\mathbf{l}\times\mathbf{1}_r/4\pi r^2 \quad - \text{ S.M.})$$
>
> between two suitable-oriented current elements are not equal and oppositely directed.

That is ALL what one can find about Grassmann's formula and, of course, the name of Grassmann can be not found in the book. To put the violation of a FUNDAMENTAL PHYSICAL LAW in a problem!!! This can be done only by CRIMINALS.

And of course there is NO contemporary textbook where one can find AMPERE'S FORMULA. Ampere's formula has been simply guillotined. Meanwhile Ampere's formula preserves Newton's third law! The writers of textbooks attach the name of Ampere to a formula which has NOTHING IN COMMON WITH AMPERE. They call the second of the above formulas "Ampere's law" (see p. 287 of Scott's book). Contemporary textbooks is a HISTORICAL MESS.

Thus, dear referee, to announce clearly WHICH is the Grassmann-Ampere controversy IS VERY IMPORTANT and you must be happiest if the "theoretical" section will be NOT deleted, so that you can understand "where the dog is buried".

The referee writes that positive effects are obtained in all mentioned by him five experiments, which I shall enumerate USING MY NAMES which must be preserved IN ANY FURTHER DISCUSSIONS:

a) the Bul-Cub machine without stator,

b) the propulsive Ampere bridge with mercury sliding contacts (the historical floating Ampere bridge constructed first by Ampere),

c) the propulsive Ampere bridge with rotating balls 'sliding' contacts, where the conducting wires are perpendicular to the legs of the Ampere bridge (experiment executed first by me),

d) the propulsive Ampere bridge with displacement current (or flying Ampere bridge),

e) the rotating Ampere bridge with displacement current (experiment executed first be me).

The referee states: "Positive effects are obtained in all experiments." As a matter of fact only experiments a, b, c, e have been carried out. The experiment d has been done by nobody. This is only an experiment PROPOSED by me and I only expect that the effect will be positive. I do not ask for the prediction of the referee, as, surely, he will be afraid to give a prediction of this experiment.

The referee writes:

> ... some part of experiments a, d, and e is open; i.e., part of the circuit is a capacitor, ideally devoid of dielectric. When a current flows, conventional theory allows the vacuum of the capacitor to absorb energy and momentum. Marinov, however, does not believe that the vacuum can do this. Hence he interprets his experiments (and that of Graham and Lahoz) as evidence for violation of conservation of momentum.

Thus the story is PRETTY CLEAR to the referee. But he EVADES to present HIS viewpoint. As a matter of fact, one cannot speak about "conventional theory". There are only different authors, there are only NAMES. And if the referee considers himself as a specialist in the field (otherwise he has to reject to be a referee of my paper), he has to give HIS predictions for the results of the above five experiments and HIS own explanation of the appearing effects. If these predictions and if these explanationa will differ from my own, I shall discuss and criticize them; if they will coincide, my paper must be published. And I ask: Do the referee agree that when my Bul-Cub machine without stator (a body of 2 KILOGRAMS) rotates, the opposite angular momentum is "stocked" in the vacuum in the form of "rotating electromagnetic energy"? I think that even the IDIOTISM of certain authors must have some limits.

I have answered all questions of the referee in my previous objections. I have exactly explained the flow of the current in fig. 4. I can only repeat this description:

> The charges come (see fig. 4) along the lower axial wire and across the pointed end of the lower small axle mount on the outer surface of the lower internal cylinder. Because of the static induction, the same amount of opposite charges gathers on the internal surface of the lower external cylinder. This amount of charges comes in the form of conduction current from the internal surface of the upper external cylinder. Because of the static induction, the same amount of opposite charges gathers on the external surface of the upper internal cylinder. These charges come along the upper axial wire from the source of electric tension to which the lower axial wire is also connected.

Is, dear referee, clear for you how the current goes? Still not? Excuse me, but if you cannot understand how is the current propagating in this CHILDISH experiment, it will be better for you to change your profession.

The referee asks again which is the difference between the Graham-Lahoz experiment and my Rotating Ampere Bridge with Displacement Current (RABDC). They are two COMPLETELY DIFFERENT experiments!!!! The Graham-Lahoz experiment is very similar to my Bul-Cub machine without stator. The difference between the last two is that in the G+L experiment the magnet is permanent and SOLID to the laboratory and there is NO dielectric between the plates of the condenser. Thus in the Graham and Lahoz experiment only OSCILLATIONS of the condenser can be observed and the flowing current is VERY LOW. In the Bul-Cub machine without stator magnet and condenser are SOLID ONE TO ANOTHER and the current flowing in the coil of the magnet and in the condenser IS THE SAME. Thus in my experiment the torque is UNIDIRECTIONAL and ENOUGH BIG, so that I bring a body of about 2 kg by INTERNAL FORCES in a continuous rotation. Every child can understand what am I doing. Only the referee of PHYSICS LETTERS cannot!

To his previous four questions, diligently answered by me in my previous comments, he adds now a fifth one:

> IS THE USE OF DIELECTRIC IN THE CAPACITOR JUSTIFIABLE?
> Admittedly it is convenient to use barium titanate as a dielectric. Having a dielectric constant of 10,000, this substance permits a given apparatus to handle

> roughly 10,000 times the current that a vacuum capacitor could handle. But the use of dielectric seems an unjustifiable way to make detectable an effect which otherwise would be quite small. This is because the currents in barium titanate are polarization currents and thus involve explicitly the movement of charge. Thus such currents are comparable to ordinary cinduction currents rather than the aethereal displacement currents in vacuo, which are the author's main concern.

In conventional electromagnetism defended by the referee there are TWO BIG LIES. The first big lie is that displacement current in vacuum generates magnetic field and reacts with ponderomotive forces to external magnetic fields. However it is clear to every (logically or UNLOGICALLY thinking) child that vacuum cannot react with ponderomotive forces to other magnetic fields as vacuum has no "pondus" (weight). Thus certain professors TACITLY assume that displacement current in vacuum does not generate magnetic field and does not react with ponderomotive forces to external magnetic fields but they FIRMLY accept that displacement current in dielectrics, called also polarization current, does. THIS IS THE SECOND BIG LIE.

With my experiment reported in the paper "Maxwell's displacement current does not generate magnetic field" - V726a I demonstrated that polarization current does NOT generate magnetic field and with my Bul-Cub machine without stator and my RABDC I demonstrated that displacement current does not react with ponderomotive forces to external magnetic fields.

The comical in the whole story is the following: In 1903 John Whitehead (PHYSIKALISCHE ZEITSCHRIFT, **8**, 229 (1903)) reported on an extremely simple and excellently executed experiment which showed that polarization current does not react with ponderomotive forces to external magnetic fields, while A. Eichenwald (ANNALEN DER PHYSIK, **11**, 421 (1903)) reported on an extremely complicated and BADLY UNDERSTOOD experiment that polarization current generates magnetic field (my analysis shows that the magnetic field in Eichenwald's experiment - exactly in the same way as the experiment of Bartlett and Corle in PHYSICAL REVIEW LETTERS, **55**, 59 (1985) - is generated not by the polarization (displacement) current but by the current in the conducting wires flowing in the wires connecting the condenser's plates). The "conventional" (i.e., pro-Maxwell) physicists refer in teir textbooks only to the BAD experiment of Eichenwald and put under the rug the EXCELLENT experiment of Whitehead. I have to add that the FRENCH physicist M. R. Blondlot FIRST (JOURNAL DE PHYSIQUE, **1**, 8 (1902)) showed that displacement current does not generate magnetic field but who is prophet in his own country (I hope that the referee or Prof. Vigier is French, isn't he).

I shall end my comments by CITING THE TEXT on the back cover of my book THE THORNY WAY OF TRUTH, Part VII, published recently, as I am tired to explain things obvious for CHILDREN whose verification can be done by CHILDREN:

> The seventh part of the collection of documents THE THORNY WAY OF TRUTH (TWT) is dedicated quite the whole to Maxwell's displacement current which, according to conventional physics, must have all magnetic properties of conduction currents. Marinov has shown that this concept is wrong. His original experiment demonstrating that displacement current does not act with potential forces on other currents was presented in TWT-I. In TWT-VII is presented Marinov's repetition of the historic Whitehead's experiment, put by the Maxwellians-Machiavellians under the rug, which demonstrates that displacement current does not react with kinetic forces to the action of other currents. Marinov is photographed above with his CHILDISHLY SIMPLE experiment which consists of a cylindrical condenser put in the orifice of a big coil. Between the condenser's plates either a metal ring or a ring of dielectric can easily rotate. The capacitances in both cases are made equal. Thus in both cases, by applying the tension of the mains, the same current flows, and the torque acting on the conduction current in the metal ring brings it in continuous rotation. According to the Maxwellians, the same torque must also act on the ring of dielectric, while the experiment shows NO TORQUE. Thus the interection between circuits interrupted by condensers is an interaction between NON-CLOSED loops and, because of Grassmann's formula, may violate Newton's third law, as Marinov has already demonstrated with his Bul-Cub machine without stator. However the knights-editors under the command of the hardy Sir John from NATURE raise their shields against Marinov's papers in a desperate effort to save pitiable scientific lies.

STEFAN MARINOV
Morellenfeldgasse 16
A-8010 GRAZ — AUSTRIA

Dr. John Maddox
NATURE
4 Little Essex Street
London WC2R 3LF

10 October 1989

Dear Dr. Maddox,

More than a month is over after our last phone conversation and no one of your promises has been fulfilled. After your telefax of the 18 July and after my letter of the 18 July you continue the same MISERABLE tactic of "an ass on a bridge". Are you not tired? I am sixty, you are certainly much more. You are Editor of a prestigious journal. How can you not understand that your behaviour of a pitiful lier is ABJECTING. If you do not wish to publish papers of me and on me, let us break our contacts, if you wish to publish such materials, then do it. Until when, Dr. Maddox, will you continue to deceive me, until when? I shall not break the contacts, as my investments are toobig. And not only for this. Also for the following reasons:

Muore la pecora,
muore l'agnello,
muore il bue
e l'asinello,
muore la gente
piena di guai,
ma i rompi coglioni
non muoiono MAI!

Have you understood the poems? No? Unfortunately I cannot translate this poem in English, because in English it will not say THIS what it says in Italian. There are not only words in a poem. One must have a HEART to feel a poem. If you cannot understand it in Italian,you cannot understand it in any other language.

Or, perhaps, you have understood the poem? Then the day in which you have read my letter was not a void day. It was a rich day, as rich was my day, a week ago, when I read this poem on the desk of the 12-years old son of my friend Paolo Brunetti in Bologna. If nothing other has occurred in a day except the reading of a similar poem as the above one, it is enough for me to say: this was a RICH day.

A couple of days ago I returned from a trip in Italy where I attended the conference organized by Prof. Bartocci in the University of Perugia. When speaking, Prof. Wesley said: "Here we are, the world's specialists in electromagnetism. Here is Graneau, here is Pappas, here is Assis, here is Marinov. Only Francisco Müller is not between us." I shouted from the audience: "But his SPIRIT is present." The conference was storming: Controversy Ampere-Grassmann; violation of Newton's third law; violation of the energy conservation and angular momentum conservation laws; has the displacement current the same magnetic properties as conduction current or not. Prof. Bartocci will publish the proceedings of the conference and you will be able to read who which thesis has defended.

But I wish to tell you another story. I asked P. Graneau:"During my visit in London Dr. Maddox said me that you have phoned him, is this true?" "Yes, answered Graneau, it is true"."Then Dr. Maddox said me that he, following my advice,has sent to you my paper 'Propulsive and rotating Ampere bridges violate the principle of relativity' for an opinion and that you have sent him a report which was hardly understandible. Is this true." "No, said Graneau, Dr. Maddox has sent nothing to me and I have not written a letter to him."

Dr. Maddox, poor Dr. Maddox, why do you lie as a dirty gipsy? Have you not in England the proverb "the legs of the lie are short"? Why have you lied in such a primitive manner?

And then you lied that someone has repeated my Rotating Ampere Bridge with Sliding Contacts (RABSC) and that it has NOT rotated. Why all these lies? Why? To have arguments for rejection of my paper? Are lies arguments, Dr. Maddox, tell me, are lies arguments? Will you by the help of lies save Einstein? By the help of SUCH lies?

Next week I shall phone you to learn when you will publish: 1. The Christmas puzzle. 2) My correspondence with Tiomno. 3) My paper on the RABSC. 4) My big paper which is already composed and had to appear on the 18 August 1988. I am a "rompi coglioni", Dr. Maddox, never forget this.

With love: *S. Marinov* S. Marinov

STEFAN MARINOV
Morellenfeldgasse 16
A-8010 GRAZ — AUSTRIA

Президенту АН СССР

Копии: Академику Сахарову
Послу СССР в Вене
Послу СССР в Берне
Д-ру С. Панкратову /НАУКА И ЖИЗН
Виталию Коротичу /ОГОНЕК/
Владимиру Бержатому /космическое объединение ЭНЕРГИЯ/

11 октября 1989 г.

Мой телефакс: 0316/8257560
Мой телекс: А-312275

Уважаемый Господин Президент!

На мое письмо Вам от 18-го мая, на мой телекс от 6-го июня и на мое письмо от 28-го июля /копия этого письма приложена/ нет никакого ответа. Мой связной в Москве, д-р Панкратов, бывал в Академии и ему господа чиновники сказали, что мои письма и телекс получены. В такой ситуации любой нормальный человек плюнул бы и сказал бы: "У этих советских людей отсутствуют элементарные навыки цивилизованных отношений." Но ведь я Россию знаю, знаю ее "опухшую ото сна", ее азиатщину и бескультурье. Знаю, однако, что среди моря заспанных чиновников рвутся к небу блистательнейшие головы. И моя надежда, что моя корреспонденция к одной из этих голов дойдет, не увядает. Дело очень важно, чтобы опустить руки перед бесчувственностью, наплевательством и самодурством чиновников.

Ни д-р Панкратов, ни мой "гонец" из Граца, д-р Дикарев, могли связаться с Сахаровым. "Так это же самое простое дело. Эта единственная дверь в Москве, которую ключом не замыкают. Идешь на улицу Чкалова 48, поднимаешья на шестой этаж, звонишь. Открывает либо сам Сахаров, либо Елена Георгиевна. При этом щеколда от перевертивания ключа не щелкает", сказал я Панкратову по телефону. "Это было в твое время, когда Сахарова как прокаженного чурались. Теперь не то" ответил Панкратов. Но самое странное сказал мне Дикарев после возвращения из Москвы. "У Сахаровых никого не было. Я позвонил в дверь напротив, чтобы соседям оставить письмо. Ответили: Не знаем, кто это такой академик Сахаров ." /Видно, боятся люди бедные, что колесо взад попятится и будут их в тускло освещенной комнате спрашивать: "А вы письмо Сахарову из капстраны передавали?"/

Да зачем нам в "литературу входить", когда мы дело должны делать, важное дело, общепланетарное.

Прошу Вас, Господин Президент, чтобы письмом ЗА ВАШЕЙ ПОДПИСЬЮ мне было сообщено: Заинтересована ли АН СССР послать человека, который бы машину ТЕСТАТИКА осмотрел. Если он убедится, что она является ПЕРПЕТУУМ МОБИЛЕ, чтобы Вы или Сахаров приехали бы также убедиться и чтобы потом наш фильм с Вашим или сахаровским вступительным словом был бы излучен московским телевидением. Если представитель Академии Наук убедится, что машина перпетуум мобиле не является и опубликует это заключение, снявшись перед машиной, в одной из газет ИЗВЕСТИЯ, ОГОНЕК, МОСКОВСКИЕ НОВОСТИ, НАУКА И ЖИЗНЬ, то я заплачу академии 20,000 долларов. Деньги могу депонировать сразу же по получении Вашего согласия об инспекции в советское посольство в Вене /подобным образом я депонировал 100,000 шведских крон в шведское консульство в Граце в 1986 г., чтобы купить одну страницу в газете ЗВЕНСКА ДАГЕБЛАДЕТ - см. НЕЙЧЕР, 21 августа 1986, стр. x/.

Прошу Вас, чтобы Ваш ответ /положительный или отрицательный/ был мне сообщен телефаксом или телексом на указанные выше номера.

Посылаю Вам приглашение, чтобы представитель Советского Союза /возможно дипломат или журналист/ посетил бы Интернациональный конгресс по свободной энергии в г. Ейнзийдельн, Швейцария, 28-29 октября. Там я выступаю с докладам посвященный машине ТЕСТАТИКА. Наш фильм о ТЕСТАТИКЕ будет показан и открыватель машины, Пауль Бауманн, будет присутсвовать.

Прилагаю мое письмо господину Виталию Коротичу от 24-го августа, которое господин В. Бержатый из объединения по космическим исследованиям ЭНЕРГИЯ обещал опустить в московский почтовый ящик. Мои попытки связаться с Бержатым по телефону оказались тщетны - телефон все время гудел странно. Россия почтовая, видно, распухала от сна. Хочу добавить, что все мои письма Вам и Сахарову я посылал скорой почтой, с оказией и с обратной распиской о получении. Ни одна из обратных расписок ко мне не вернулась. А вчера я получил скорое письмо, которое позавчера было послано в Цюрихе. Учтите, Президент, советская почта начнет работать только тогда, когда ВАШИ чиновники начнут отвечать на письма, которые они получают. А если они дрыхнут в Академии, их нужно немедленно выгнать. А если Вы их не выгоните, то ВАС нужно выгнать.

Я обращаюсь к ВАМ с ОЧЕНЬ ВАЖНЫМ ВОПРОСОМ.

Искрение Ваш: С. Маринов
Стефан Маринов

Editorial note. This letter as well as all preceding ones remained without answer.

STEFAN MARINOV
Morellenfeldgasse 16
A-8010 GRAZ — AUSTRIA

12 October 1989

Dr. J. Fischer
CZECH. J. PHYS.
Na Slovance 2
CS-180 40 Praha 8

Ref. No. 2952

Dear Dr. Fischer,

Thank you very much for your letter of the 3 October 1989 concerning my paper

ACTION OF CONSTANT ELECTRIC CURRENT...

If you have perused my books THE THORNY WAY OF TRUTH, you could see that in the last 20 years I submit papers to ALL physical journals in the world. Almost ALL "relativity oriented journals" either have broken the contacts with me, or examine my papers for years and years, answering any third or fourth of my letters. It was a battle, a very heavy battle. For the publication of my big paper in NATURE: EXPERIMENTAL VIOLATIONS OF THE PRINCIPLES OF RELATIVITY AND EQUIVALENCE AND OF THE LAWS OF ENERGY AND ANGULAR MOMENTUM CONSERVATION I visited FIVE TIMES Dr. Maddox in London, exchanged in the last five years at least 1000 phone calls, and hundreds of letters and telefaxes (a part of the letters and the telefaxes is published in TWT). I was twice in London to COMPOSE the paper on the computers of Dr. Maddox. It was scheduled to appear first on the 18 August 1988, then on the 13 October 1988 and it still has not appeared and one can read the COMPOSED version only in TWT-III. As all seems unbelievable, I send you the telefax of Dr. Maddox of the 18 July and my answer. There you can see that Dr. Maddox even rejects the publication of a prepaid advertisement from me.

However, the truth which is contained in my papers and in my experiments is such that it will overwhelm the resistance of the so-called "relativists", some of whom (as the leading "relativists", Bondi, Bergmann, Wheeler, Sciama) have since many years understood that relativity is dead and other (as Dr. Langer and the majority of the "unconsecrated") believe that relativity is a right theory. The most important arm in my hands are my experiments violating the laws of conservation and first of all the machine TESTATIKA, constructed in the Christian-communist community Methernitha (of which I am a member) which is a perfectly functionning PERPETUUM MOBILE (my book TWT-V is dedicated quite the whole to TESTATIKA).

The world will ACCEPT the scientific truth. But if I am not active, if I do not submit papers to journals, if I do not publish books and organize congresses, the recognition of the scientific truth (which is from an enormous importance for the ecological survival of mankind) will be delated for months and years.

For this reason I give you the following suggestion: Let us await for the opinion of the referee to whom you have sent my paper, sending him a letter to elaborate this opinion as soon as possible, or to reject the examination. I assure you that the opinion will be negative. Nevertheless, send this opinion to me, so that I can publish it in TWT. If this referee will be not willing to write a referee opinion, I should suggest that you send the paper for an opinion to the GOOD space-time specialist Peter (PETR) Beckmann, Box 251, Boulder, CO 80306, USA, the editor of the new journal Galilean Electrodynamics. Beckmann first is a Czech, second a Jew and thus you can be sure that he will be impartial (he is the author of the book EINSTEIN PLUS TWO). Let us see which will be his opinion.

Let me remember that CZECH. J. PHYS. was the first world journal which has published the report on an optic experiment disproving the principle of relativity. Let us make the CZECH. J. PHYS. also the first world journal which will publish the report on an electromagnetic experiment disproving this principle. Soon the authority of your journal, due to the publication of these two articles, will be widely recognized.

As you are very kind to me, I hope that you will acknowledge the reception of this letter and you will inform me about the decision which you have taken.

Enclosed find an invitation for the congress on free energy which we organize in Einsiedeln, Switzerland. If somebody from Prague should like to visit the congress, write in my name to the organizer, Peter Engeler, and ask him whether SAFE can pay the trip and the sojourn of some representatives of Czechoslovakia who have enormous difficulties in getting Western currency.

Sincerely yours, S. Marinov

STEFAN MARINOV
Morellenfeldgasse 16
A-8010 GRAZ — AUSTRIA

12 October 1989

Dr. Petr Beckmann
GALILEAN ELECTRODYNAMICS
Box 251
Boulder
CO 80306

Dear Dr. Beckmann,

Today I learned that you start in January the publication of the journal GALILEAN ELECTRODYNAMICS (my informant from the States, Henry Palka, a friend of Prof. Hayden, sent me the announcement leaflet).

If you will succeed to make a well edited and representative journal, this will signify the advent of a new era in physics. I was fascinated by the program of your journal, where the principles for choising the articles are: clarity, simplicity, adequacy to the experimental evidence.

I will be very glad to become a member of the editorial board and to do my best for promoting the journal. Prof. Barnes knows me well from the anti-relativity conference which we organized in April 1988 in Munich (Prof. Barnes took also part in the anti-relativity conference in Pulkovo, Leningrad, and I take an active part in the organization of the next such conference in the USSR). Prof. Hayden knows about me, surely through Henry Palka and through Prof. Domina Spencer who also visited the conference in Munich.

I have never been in contact with you. But I know your work in space-time physics very well and I was delighted when reading your book EINSTEIN PLUS TWO. Enclosed are some pages from the sixth volume of my series THE THORNY WAY OF TRUTH, where you can see that I have "discovered" Michelson's paper in ASTROPH. J. (1913) by reading your book.

I submit to your journal the following papers (it is good to publish them in this order):

1. THE ELECTROMAGNETIC EFFECTS ARE DETERMINED BY THE POTENTIALS AND NOT BY THE INTENSITIES.
2. MAXWELL'S DISPLACEMENT CURRENT DOES NOT GENERATE MAGNETIC FIELD.
3. EXPERIMENTAL VIOLATION OF AMPERE'S FORMULA AND OF NEWTON'S THIRD LAW.
4. VERY EASY DEMONSTRATION OF THE VIOLATION OF THE ANGULAR MOMENTUM CONSERVATION LAW AND OF THE FAILURE OF CONVENTIONAL ELECTROMAGNETISM.
5. EXTREMELY EASY EXPERIMENT DEMONSTRATING VIOLATION OF THE ANGULAR MOMENTUM CONSERVATION LAW.

Ed. note. See the answer on p. 312.

If you will have a section LETTERS TO THE EDITOR, I submit for it my letter:

A COMMENT ON W. A. SCOTT MURRAY'S ARTICLE.

I shall be very glad if some of these articles will appear in the first issue of the journal. Write me at due time, so that I can prepare the diskette.

For information I send you the following materials:

a) A letter to the editor from the INT. J. GENERAL SYSTEMS (his editor, G. Klirr is as you a Czech; I spent my youth in Prague, visiting to Soviet school "na Pankraci" and if it will be a pleasure for you, you can write to me in Czech).

b) My advertisement from NEW SCIENTIST: Marinov to the world's scientific conscience.

c) The abstract of my speech for the GR-12 Conference (I did not visit the conference as N. Ashby did not allow me to project the 40-minutes film on the first perpetuum mobile on the Earth, the machine TESTATIKA).

d) My address: Marinov to the participants of the aether conference which was not accepted to be published as announceement neither by NATURE nor by NEW SCIENTIST.

e) The invitation for the free energy conference in Einsiedeln, Switzerland, to which you are warmly welcome.

Sincerely yours, S. Marinov S. Marinov

PS. The papers are in single copies; I shall gladly pay for the photocopies which you will eventually make.

STEFAN MARINOV
Morellenfeldgasse 16
A-8010 GRAZ — AUSTRIA

13 October 1989

Prof. Taizo Masumi
JPSJ
Physical Society of Japan
Kikai-Shinko Bldg.
3-5-8 Shiba-Koen
Minato-ku
Tokyo 105

Ref. Nr. 1031

Dear Prof. Masumi,

With a letter of the 30 January you acknowledged the reception of my papers:

1031 Absolute and Relative...

1032 Extremely Easy...

1033 Propulsive and Rotating...

With your letter of the 11 September 1989 you rejected the papers 1032 and 1033.

Please, be so kind to inform me which is your decision concerning paper 1031!

The referee report on my papers 1032 and 1933 is so bad that I am shocked to read such a report from such a prestigious journal as yours.

In my papers I report on the execution of experiments which VIOLATE a fundamental physical law. Your referee does not mention at all my experiments and which is his view-point to the reported results. The Lorentz equation DOES NOT GUARANTEE the conservation of momentum (and angular momentum) and this is WRITTEN il almost ANY textbook on electromagnetism. One shows only that for the interaction of CLOSED current loops the law of conservation of momentum is conserved but for OPEN loops it is NOT. Until now (besides the experiment of Graham and Lahoz, NATURE, 1980) there are only MY experiments which are done with OPEN current loops (interrupted by condensers) and these experiments DEMONSTRATE violation of the angular momentum conservation law. Your referee had to DISCUSS my experiments and present his view-point.

You refreee writes:

> Ampere's formula as well as Grassmann's one, on which this paper is based, are nothing more than the approximate form of the Maxwell equations.

This is not true and ANY student knows this: Ampere's formula has nothing in common neither with Maxwell's equations nor with the Lorentz equation. Grassmann's formula is not a result of the Maxwell equations but an EXACT form of the Lorentz equation.

I repeat, I am SHOCKED by the low scientific level of your referee and I beg you to send me an opinion on paper 1031 of a COMPETENT scientist who is acquainted with the present state of the Ampere-Grassmann discussion.

At the end of September there was a conference in Perugia, Italy, where the most important scientists working on the Ampere-Grassmann controversy have taken part (Graneau, Pappas, Wesley, Assis, Marinov). Your referee must become acquainted with the papers of these persons.

Looking forward for your decision on paper 1031,

Sincerely yours,

S. Marinov

Stefan Marinov

Editorial note.

Dr. Masumi answers the above letter with his own of the 24 October 1989.

OPTICS LETTERS
A publication of the Optical Society of America

October 19, 1989

Dr. Stephan Marinov
Institute for Fundamental Physics
Morellenfeldgasse 16
A-8010 Graz, Austria

Re: *New Measurement of the Earth's Absolute Velocity with the Help of the 'Coupled Shutters' Experiment*

Dear Dr. Marinov:

I am returning your manuscript since publication in Optics Letters does not appear to be reasonable.

The expertise and interests of the readership of Optics Letters does not match the topic which involves very fundamental questions in relativity. May I suggest you send the manuscript to a more general physics journal or to one which concerns itself with fundamental problems in relativity.

Sincerely yours,

Paul L. Kelley (ECH)
Paul L. Kelley

PLK/ech

Editorial note. The above paper is published in TWT-II, p. 68.

P. L. Kelley, Editor P. A. Rogers, Assistant to the Editor
Mail: Optics Letters, MIT Lincoln Laboratory, Lexington, MA 02173-0073
Telephone: 617-276-6733 Facsimile: 617-276-6721

PHYSICAL SOCIETY OF JAPAN
Kikai-Shinko Building, 3-5-8 Shiba-Koen, Minato-ku
Tokyo 105, Japan

October 24,1989

Dr. Stefan Marinov
Inatitute for Fundamental
Physics,
Morellenfeldgasse 16,
A-8010 Graz,
Austria

Dear Dr. Stefan Marinov

Your manuscript # 1031 entitled

Absolute and Relative Newton-
Lorentz Equations

was examined by a referee. His judgement is that your manuscript is not appropriate for publication in our Journal. Referee's comments are enclosed herewith.

We are returning your manuscript to you.

Sincerely yours,

Taizo Masumi
Editor-in-Chief

"著者に対する注意" はこの
複写して著者に送らせていた
ますので御了承下さい。尚,
を希望されない場合はその旨
し出下さい。

Journal

著者に対する注意

1031

I carefully read this paper but I could not find anything worth
o be published in the journal.

The author asserts that he found the third type of induction.
t is derived from his mistaken transformation for the electric
otential Φ .

the Special Theory of Relativity, the electric(scaler) potential
transformed by $\Phi' = \Phi - \mathbf{V}\cdot A/c$. If the author correctly
es this transformation in place of his relation, $\Phi' = \Phi$, he could
sily show the equality in the first and the third cases.

is equality means that the relativity holds in electromagnetism,
ich is the point where Einstein started to construct the Special
eory of Relativity.

I cannot believe the author's assertion because that there is
reason to reject the relativity.

Editorial note.
Marinov answers the above letter with his own of 24 November 1989.

PHYSICS ESSAYS

AN INTERNATIONAL JOURNAL DEDICATED TO FUNDAMENTAL QUESTIONS IN PHYSICS

Editor:
E. Panarella

31 October 1989
PE1683/kla

Dr. Stefan Marinov
Institute for Fundamental Physics
Morellenfeldgasse 16
A-8010 GRAZ
AUSTRIA

Re: Manuscript: ABSOLUTE AND RELATIVE NEWTON-LORENTZ EQUATIONS, by Stefan Marinov, submitted for publication in Physics Essays (received 9 March 1989).

Dear Dr. Marinov:

Please find enclosed a review of your paper.

As you know, the Editorial Policy of "Physics Essays" prescribes that authors should take an objective and careful look at the reviewers' reports in order to see if there are elements of value that can be used to improve the quality of their papers, on both the aspects of correctness and of clarity of exposition, and this is what I am encouraging you to do now.

In particular, I believe you should address the several questions raised by the reviewer, because they touch upon the correctness of your arguments and of the conclusions, and therefore are serious enough to warrant your full attention.

Since I would like to keep a tight schedule on this process of revision, I would therefore like to have your revised manuscript, in triplicate, back to me by 28 December, 1989, at latest. Moreover, in retyping the manuscript, please follow the Instruction to Authors here enclosed.

I thank you for having submitted your paper to us.

Sincerely yours,

E. Panarella

Editorial note. Marinov answers the above letter with his own of the 15 November 1989.

Encl.

c/o National Research Council, Rm. 100 Bldg. M10, Ottawa, Ontario K1A OR6, Canada
Tel: (819) 770-0477, Fax: (819) 770-3862

Review of Article by Stefan Marinov

Usually, I am sympathetic to articles which are a little off-beat or take unusual approaches to new physics. It is always good to reanalyze the foundations behind our physical assumptions. However, I am also aware that, the more eccentric or unorthodox the article is, the more it must substantiate its claims, especially when calling into question well-established results. The burden of proof rests strictly on the author who claims to find a deviation in traditionally accepted physics.

In the case of Stefan Marinov's article, I do not see that his claims are supported by either theory or experiment.

The author calls into question basic tenants of Maxwell's equations and special relativity. This by itself is okay. But, as I mentioned, he must offer convincing evidence of the correctness of his ideas in order to challenge something so fundamental and so well-established.

I do not find his theoretical work convincing. His equations assume a deviation from the usual Maxwellian interpretation, and hence it is not surprising that he finds evidence for "absolute" motion. For example, usually in electrostatics the Lorentz force can be derived from a simple covariant expression involving certain contractions on a second-rank tensor, the Maxwell tensor.

Written in this way, the Lorentz force equation is manifestly covariant under O(3,1) transformations and hence independent of absolute motion. In fact, all the laws of electrostatics can be simply reformulated covariantly using the Maxwell tensor so that there is never any need to single out absolute reference frames at any point in the calculation.

It is easy to trace the origin of the author's error. The fact that the author finds that his equations have absolute velocities in them can be traced back to the fact that he has modified the covariant Lorentz force equations to suit his own tastes.

In other words, because he put in non-covariance into his equations in the first place, we should not be surprised to find non-covariance in his results. Since the author has chosen to write a modified version of the covariant Lorentz force equation in a particularly non-covariantly way, it is not surprising that non-covariant expressions result from his equations. However, the author gives no fundamental reason for this particular deviation from covariance. (Personally, I find it disturbing that the author can be so casual and nonchalant about tinkering around with electrodynamic equations.)

Furthermore, there are obviously an infinite number of ways in which one can deviate from covariant equations, and hence an infinite number of non-covariant equations can result, so why should we believe his particular choice rather than another equally obscure choice? The answer must ultimately come from experiment.

He offers the experimental work of Kennard, which are 70 years old and hence unreliable, and the more recent work of Muller, which have been mentioned in the literature only through the author's papers. Therefore, I do not see convincing experimental evidence for his theories. This is important, because he is challenging the wealth of experimental evidence supporting the traditional Maxwell-Einstein approach to electrodynamics, which has survived all challenges over the past century. Any challenge to a theory which has held up over the past 100 years must be grounded in absolutely fool-proof experimental work.

In summary, I do not feel that this paper is correct, nor does it add to our fundamental understanding of physical laws. To deviate from conventional wisdom is always welcome, but only if it is well grounded theoretically or experimentally. I find neither. The burden of proof is on the author, and he does not give a convincing argument for this thesis.

Regrettably, I do not have time to engage in a lengthy correspondence with the author if he disputes my comments, but I am sure than any qualified referee would agree with the substance of my comments. However, I might suggest the following alternative referee for future discussion, who is an authority on electrodynamics:

International Journal Of Theoretical Physics
Georgia Institute Of Technology
Atlanta, Georgia 30332-0430
(404) 894-5220

10 November 1989
(post stamp date)

We are sorry to say that our current publishing program is not appropriate for your paper, which we return to you with this.

We hope that you will not be discouraged by this decision. While physics is an exact science, physics publishing is not. Frequently papers declined by one publication are accepted by another with different requirements.

We are unable to provide a written review of your paper.

Thank you for letting us read your paper for IJTP.

Ed.

INTERNATIONAL JOURNAL OF THEORETICAL PHYSICS

Address for proofs and correspondence

Stefan Marinov
Institute for Fundamental Physics
Morellenfeldgasse 16
A-8010 Graz, Austria

MS 890802-M

Pages + Figures
18+11 pp

Author(s)
Stefan Marinov

Title of paper
The Myths in Physics

Editorial note. The above paper is published on p. 59 of TWT-III.

STEFAN MARINOV
Morellenfeldgasse 16
A-8010 GRAZ — AUSTRIA

4 November 1989

Prof. Taizo Masumi
JOURNAL OF THE PHYSICAL
SOCIETY OF JAPAN
Kikai-Shinko Bldg.
3-5-8 Shiba-Koen, Minato-ku
Tokyo 105

Dear Prof. Masumi,

Thank you for your letter of the 24 October, although I must confess that I was again unpleasantly shocked by reading the comments of your referee on my paper

ABSOLUTE AND RELATIVE NEWTON-LORENTZ EQUATIONS,

as I did not find a difference between the comments of your referee and the comments which I receive from the referees of the physical journals in Europe and America. Meanwhile, considering the Japanese scientists as free from the bonds which tie the scientists of the white race to the relativistic concepts, I hoped to receive from your journal a physically and MATHEMATICALLY motivated rejection.

By jumping from frame to frame and by playing with transformation formulas (of which the relativists do NOT understand the physical essence) one shows NOTHING. In my paper I pose the problem: Which will be the electric intensity induced at a certain reference point in a given reference frame if a magnet, generating at this reference point a magnetic potential $\mathbf{A}$, moves with a velocity $\mathbf{v}$. I said in my paper that if a relativist will solve this problem MATHEMATICALLY and write me the result with black ink on white paper (the relativists expect that the result will be $E = - \mathbf{v}\times\text{rot}\mathbf{A}$), I shall send to this man 3000 \$. No transformations are to be done to other reference frames. One has to solve the problem in the frame in which the problem is POSED where the magnet moves and the reference point is at rest.

I solve in my paper the problem and I give the result:

$$E = (\mathbf{v}.\text{grad})\mathbf{A}.$$

I think that for you, as an Editor of one of the most authoritative physical journals remain only two possibilities: Either to send me a MATHEMATICAL solution of the problem done by your referee and to receive from me 3000 \$ (which then you can share with your referee) or, in the case that your referee will be UNABLE to solve this CHILDISHLY SIMPLE MATHEMATICAL PROBLEM, to print my paper.

If you will do neither the first nor the second, you are not an Editor of a SCIENTIFIC journal.

Thus I send you back my paper and I expect for your quick decision.

To this resubmitted paper I attach now also my paper

ACTION OF CONSTANT ELECTRIC CURRENT ON ELECTRONS AT REST DUE TO THE ABSOLUTE VELOCITY OF THE EARTH,

where I show how have I observed experimentally the effects predicted by me and I beg you, in the case that your referee will fail to solve the above mentioned problem, to print my two papers one after the other.

For yours and your referee's information I enclose my advertisement MARINOV TO THE WORLD'S SCIENTIFIC CONSCIENCE published in 1986 in NEW SCIENTIST. I beg your referee to give HIS predictions to the experiments shown on p. 49 of the advertisement:

Will be there tension induced in the wire $b\text{-}b_0$ for the following cases:

CASE	Predictions of: Einstein	Marinov	The referee	
	rotational & translational		rotational	translational
1. Loop at rest, wire moving	yes	yes		
2. Wire at rest, loop moving	yes	no		
3. Wire and loop moving together	no	yes		

I beg you to send me an acknowledgement for the reception of this letter and then in due time to send me your decision.

Yours: S. Marinov Stefan Marinov

d. note. There was no answer of Dr. Masumi.

STEFAN MARINOV
Morellenfeldgasse 16
A-8010 GRAZ — AUSTRIA

До г-жа министър на правосъдието
Светла Даскалова
Министерство на правосъдието
София

13 ноември 1989

Уважаема Госпожа Даскалова,

През 1981 г. с указ на Държавния Съвет ми беше отнето българското гражданство и конфискувана къщата в София, без на мене да ми беше изпратено каквото и да е съобщение за тази напълно незаконна санкция от страна на държавата към един български патриот и комунист.

На 19 април 1982 г. научих по неофициален път за лишаването ми от гражданство и веднага изпратих следното писмо на Председателя на Държавния Съвет, г-н Тодор Живков, което впоследствие публикувах в руското списание КОНТИНЕНТ, Париж, през ноември 1982 г., в моята книга "Изыди, Сатана!" и в том I на моята поредица от научна документация, разрушаваща основите на съвременната физика, THE THORNY WAY OF TRUTH:

ПИСЬМО СТЕФАНА МАРИНОВА ПРЕДСЕДАТЕЛЮ ГОСУДАРСТВЕННОГО СОВЕТА НАРОДНОЙ РЕСПУБЛИКИ БОЛГАРИИ ТОДОРУ ЖИВКОВУ

Господин Председатель,

Сегодня, 19-го апреля 1982 г., неофициальным путем я узнал, что указом №3039 от 28 декабря 1981 г., подписанным Вами, я лишен болгарского гражданства и вся моя движимая и недвижимая собственность подлежит конфискации. Санкция мотивирована тем, что моя деятельность наносит вред интересам Народной Республики Болгарии.

Желаю довести до Вашего сведения, что Болгария конституционное государство, управляемое законами, а не прихотями и капризами административных лиц. Ваше мнение относительно того, вредит ли моя деятельность интересам НРБ, совсем недостаточно, чтобы я был лишен болгарского гражданства. Эту санкцию может дать только суд, где прокурор предъявляет обвинение и где я могу защититься.

Готов в любой момент прибыть в Софию и показать перед судом, что моя деятельность физика, социалиста и пацифиста не только что не вредит интересам НРБ, но исключительно необходима, чтобы провести процесс демократизации и демилитаризации Болгарии как можно более быстро и более радикально и чтобы имя болгарской науки было поднято высоко перед миром. Я не Ленин, чтобы бояться предстать перед государственным судом и пытаться укрываться тут или там. Уважаю суд НРБ и приму с полным удовлетворением любой его приговор, будь он и несправедливый, твердо зная, что несправедливый приговор тяготеет не над осужденным, а над тем, кто его произносит. Но если Вы лишите меня возможности предстать перед законным судом в Софии, значит, суд боится меня.

С уважением

Стефан Маринов

Както и очаквах, на това писмо не получих никакъв отговор, тъй като, очевидно, българския съд се уплаши, че мога да спечеля делото.

В българското посолство във Виена, където винаги бивах любезно приет, тогавашния консул /ако не ме лъже паметта, на име Димитров/ на моя въпрос, дали ще бъда пуснат да влеза в България за да се боря за възвръщане на гражданството, ми каза: "Стефане, не си харчи парите и не си губи времето да ходиш до Драгоман. Ще бъдеш върнат."

През октомври-ноември 1987 посетих Москва и моя приятел, академик Сахаров, за да се убедя с очите си, че шеметния процес на социално, правово и духовно преустройство в страната на съветите е действителна реалност и след завръщането ми в Австрия подадох скромна молба до българското посолство във Виена за възвръщане на гражданството. Никакъв отговор не получих, но на моите неколкократни запитвания при посещения в посолството и в писма настоящиятконсул, г-н Славчев, който винаги е изключително мил и любезен към мен, неизменно ми отговаряше: "Молбата е препратена в София. Чакаме отговор."

След като година и кусур такъв отговор не дойде, запитах г-н Славчева дали ще бъда пуснат да влеза в България за да ускоря изработването на отговора. Твърде бързо получих от г-н Славчев документ, че българските "компетентни власти" ми разрешават да посещавам свободно България и през септември тази година заминах за София.

След посещенията си при изключително любезния, симпатичен и делови г-н Явор Панчев в министерството на правосъдието и на консулския отдел във външното министерство установих, че моята молба въобще никъде не е зарегистрирана, т.е., че някой, някъде, по някое време ѝ е "драснал кибрита". Вярвам, досящате се, че аз не можах да разбера кой, къде и кога, тъй като операцията е била извършена следвайки заветите на известния английски песнописец Шели: " И не ще узнае никой де, кога, веднаж се издрискал нейде някой в цъфналата ръж".

Господин Панчев ми каза, че по принцип съм амнистиран и че трябва да подам отново молба, тъй като от старата няма ни помен ни следа. "Г-н Панчев, отговорих, в живота си съм подал 5,000 жалби, молби и заявления, т.е. на всеки три дена от живота ми средно по една. Че колко му е да подам пет-хиляди-и-първата." И се бръкнах да си извадя от джоба вечно-пишещата писалка, тя, милата, нали никога не засъхва. "А-а-а, не, отговори г-н Панчев. Ще се качите на влака и ще идете във Виена, където ще я подадете. Приемното време на посолството е от десет и половина до идинайсе и питнайсе." "И след това, запитах, Виена посредством вътрешното..." "Не. Посредством външното." "Простете, посредством външното министерство, ще препрати молбата в София?" "Точно така." "И молбата ми ще дойде при Вас?" "Точно така, при мене." "Г-н Панчев, казах, 45 години вече, айде да не броим годините от първото, второто и третото царства, българите вместо да ходят да берат доматите, да скубят чукундура и да друсат сливите се разтакават от едно учреждение във друго да подават молби, жалби и заявляния. От такова разтакаване претъпкахме трамваите и автобусите в градовете, а нивите, пастбищата и ливадите опустяха. Така или иначе, обаче до сега все пак разтакаването ставаше в рамките на държавата. Но сега в процеса на нашата българска перестройка ако почнем да разтакаваме гражданите да подават молбите, жалбите и заявленията по европейските и други столици, то ще претъпкаме влаковете и самолетите по целия свят и не само селата в България ще опустеят. Не е ли ясно и на пет-годишно дете, че най разумното е да седна да напиша тука молбата и да Ви я дам в ръцете? Оставете моето време, дето ще го губя да бия път до Виена, но на колко български дипломати и министерски чиновници ще спестим времето и усилията за да бъдат вложени в друга народополезна дейност." "Уви, разтвори ръце г-н Панчев, с усмивката на умен човек, казваща 'разбирам Ви напълно и съм съгласен с Вас', но какво да правя: такива са предписанията, разпоредбите и инструкциите идващи от висшите инстанции."

"Ами ако и този път молбата ми не ще може да дойде от Виена до Вашите ръце. Тогава, запитах, какво да правим?" "Ами ще подадете трети път... Третия път сигурно ще дойде. Вие нали в Австрия живеете?" "Да, в Австрия." "А в Австрия нали немски говорят?" "Да, викам, немски." "А немците не казват ли Alle guten Dingen sind drei?" "Казват." "Ами тогава?"

Пред тази несъкрушима логика не ми оставаше нищо друго, освен да се метна в 12 нула-нула на Окцидент експрес.

След пет-часова дремане на загребачката гара, понеже окцидент-експреса /мамка им на турците!/ не успя да направи връзка с виенския влак, стигнах благополучно Виена и подадох на 9 октомври в посолството в определеното приемно време молбата, копие от която прилагам.

На 2 ноември получих от консула, г-н Славчев, писмо, копие от което също прилагам.

Баста, уважаема г-жа Даскалова. БАСТА!

Когато ми се отнемаше гражданството никой не ме попита какво ми е имотното състояние и дали имам квартира. Аз не си възстановявам загубено гражданство, а искам да ми се върне гражданството, което незаконно ми беше отнето. Вината за лишаването ми от гражданство е на държавата и държавата, ако действително иска да стане правова държава /а държавата, в случая, сте ВИЕ!/ трябва САМА да поправи грешката си.

В случай, че Вие смятате, че съм бил законно лишен от гражданство, моля да ми представите точно буквата на закона, който съм престъпил, и с КАКВА МОЯ ДЕЙНОСТ.

Вие сигурно ще кажете: "Капризи. Милиони бяха разстреляни, без да им се каже една дума за какво ги разстрелват, той седнал да пита, защо бил лишен от гражданство." Права сте, г-жа Даскалова, да не капризничим.

Обръщам се към Вас в дните на решителни промени в социално-обществения живот на социалистическите страни. Ново вино в стари мехове не се налива. Да сложим край не само на безчовечието, на жестокостите и на безверието в българина, но и на бюрократичната глупащина, която като червоточина разяжда сградата на нашата държава.

Много добре знаете Вие и тези, които са около Вас, кой съм, какво съм и кой и защо ми беше отнел гражданството. Моля Ви, бъдете разумна и ми възвърнете гражданството, както това подобава на министър на правосъдието на правова държава.

В случай че Вие откажете, или продължите за искате от мене да Ви представя удостоверение от арменския поп, че не съм камила, предявявам иск спрямо държавата за незаконно отнемане на гражданство и на имота ми в София.

Моля Ви в такъв случай най-учтиво да назначите съдебно разглеждане на моя иск спрямо държавата и да ме уведомите за деня на процеса. Ще се защищавам сам, тъй като на българските адвокати ще им са нужни още години за да се научат как се защищават дела на гражданите.

Моля Вашия отговор, който вярвам няма да закъснее, да бъде подписан от Вас лично.

Искренно Ваш:

С. Маринов

Стефан Маринов

ПП. Прилагам моята книга ИЗЪДИ, САТАНА! за да видите какво ми е имотното състояние и месечния доход. Осем години съм коняр в един яхър, от никаква инстанция не съм получил лев за моята експериментална, теоретическа, издателска и организационна дейност, но успях да изведа българската физика на световната сцена и когато по световните научни конгреси се споменава името МАРИНОВ, на жалките айнщайнови епигони им треперят мартинките, и пигмеите стигнаха до там, че с белезници на ръцете да ме извеждат от конгресите.

Копия до:

1. Заместник-министъра на правосъдието, г-н Ефтим Стоименов.
2. Консула на НРБ във Виена, г-н Б. Славчев.

STEFAN MARINOV
Morellenfeldgasse 16
A-8010 GRAZ — AUSTRIA

15 November 1989

Dr. E. Panarella
PHYSICS ESSAYS
Nat. Research Council
Room 100, Bldg. M10
Ottawa
Ontario K1A 0R6

Dear Dr. Panarella,

I read very attentively your letter of the 31 October and the referee's comments on my paper

ABSOLUTE AND RELATIVE NEWTON-LORENTZ EQUATIONS.

I do not see how can I revise my paper in the light of the referee's comments, as he does not present some particular and well defined suggestions. The referee thinks that my whole theory is wrong, that there is no absolute space and that the electromagnetic effects depend only on the relative velocities of the interacting particles. I CANNOT revise my paper to satisfy the referee as I sustain EXACTLY THE OPPOSITE, namely that my theory is right and present space-time physics, called generally "theory of relativity", is wrong, that an absolute space does exist (I have measured a couple of times the velocity of our Earth with respect to this absolute space) and that the electromagnetic effects depend NOT on the relative but on the absolute velocities of the interacting particles. And I present EXPERIMENTS which confirm my concepts showing the untenability of the relativistic concepts.

Concerning the experimental evidence for my concepts, the referee presents the following objection:

> He (i.e., Marinov) offers the experimental work of Kennard which is 70 years old and hence unreliable...

Thus the referee raises doubts whether Kennard's experiment was well done. Well. Let us accept the doubts of the referee. I like VERY MUCH doubting people and Descartes credo "doutes en tout" is my own credo. But let us throw a look at Kennard's experiment (put by the relativists under the rug) considering it only as a Gedankenexperiment (see the first figure beneath). According to this Gedankenexperiment:

a) If the wire $b\text{-}b_0$ will be rotated between the two wires of the double concentric loop in which certain current I flows, then an induced electric tension will appear between the extremities of the wire $b\text{-}b_0$.

b) If the double circular loop will be rotated, then tension in $b\text{-}b_0$ will be not induced.

c) If wire and loop will be rotated together, then the same tension as in the first case will be induced.

These are MY predictions (and the results of Kennard's experiment).

WHICH ARE THE PREDICTIONS OF THE REFEREE? I beg the referee to give his OWN predictions, but I AM SURE that he will NOT give them, as if the referee will begin to ruminate over this experiment, then in 10 minutes he must come to the conclusion that relativity is a wrong theory and that I am right (and Kennard too).

The referee writes:

> Regrettably, I do not have time to engage in a lengthy correspondence with the author if he disputes my comments...

I do not like to go in a "lengthy correspondence". I only ask for the referee's predictions in Kennard's CHILDISH experiment. If the referee will refuse to give his predictions (and I repeat once more that he WILL REFUSE), I think, dear Dr. Panarella, that you have to disqualify your present referee and to search for another one.

To show that Kennard's experiment is VERY IMPORTANT, I reproduce on the next page the letter of Dr. Kurti, the previous Editor-in-Chief of EUROPHYSICS LETTERS, of the 9 January 1989 and my comments.

Dr. Maddox did not publish his "Christmas puzzle" on the 22 December 1988. In letters, telefaxes and phone calles (the letters and the telefaxes are published in TWT-V and TWT-VI) Dr. Maddox promised to publish the puzzle first for Easter, then for Whitsun, then for Mary's Assumption. Now Dr. Maddox gives me the solemn promises that the puzzle will appear again as a "Christmas puzzle" on the 21 December 1989. I can put 10:1 that Dr. Maddox again will be afraid to publish the puzzle, as he knows pretty well that after its publication the theory of relativity WILL BE DEAD.

I send back the copy of my above mentioned paper begging you to publish it and then to continue with the publication of my other articles which present experimental violations of the principles of relativity and equivalence, of Newton's third law and of the laws of conservation of angular momentum and energy.

I beg you to acknowledge the reception of this letter and then in due time to inform me about your final decision.

Sincerely yours: S. Marinov S. Marinov

UNIVERSITY OF OXFORD
DEPARTMENT OF ENGINEERING SCIENCE
Postal Address: Department of Engineering Science, Parks Road, Oxford OX1 3PJ
Telephone: Direct Line: (0865) 273115 Switchboard: (0865) 273000 Telex: 83295 Nuclox G FAX +44 865 272400
From: Professor N. Kurti, C.B.E., F.R.S.

9 January 1989.

Dr. Stefan Marinov,
Morellenfeldgasse,
A-8010 GRAZ
AUSTRIA.

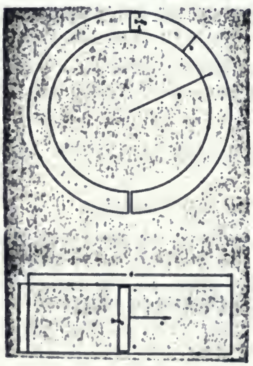
Dear Dr. Marinov,

Mrs. Bouldin of the European Physical Society has sent me a copy of your letter to her dated 22 December 1988. You mention an article by Dr. Maddox entitled "Christmas puzzle" which appeared in "to-day in NATURE", Could you please send me the full reference i.e. date of issue and page number.

Yours sincerely,

N. Kurti

N. Kurti.



Marinov's note. (see also Marinov's letters to Dr. Kurti and Dr. Maddox of the 13 January 1989).

During my visit in London on the 14 and 15 December 1988, Dr. Maddox promised me that on the 22 December he will publish under the title "Christmas puzzle" the figures given here on the left side which were published in my 3-pages paid advertisement "Marinov to the world's scientific conscience"in NEW SCIENTIST, 112, 48 (18 December 1986) as a "Christmas puzzle" for the scientific year 1986.

In the first experiment there is a double circular wire forming a loop along which a constant current flows and a radial piece of wire placed between both circular wires of the loop whose middle radius R is much bigger than the length of the wire $b - b_0$. The experiment of Kennard (Phil. Mag., 33, 179 (1917)) has shown: 1)if rotating the wire,a tension will be induced in it, 2) if rotating the circular loop, no tension will be induced in the wire, 3) if rotating loop and wire together the same tension as in the first case will be induced.

Now I am asking which will be the issues of the second experiment consisting of a very long rectangular loop in which the same current flows and in which a wire with the same length is placed for the three cases: 1) motion of the wire, 2) motion of the loop, 3) motion of the loop and wire together. I affirm that the answer of any normally thinking child will be as for the first case. Thus any child older than 12 years solves this "puzzle" in a minute giving a kick to the idiotic Einstein theory, as THERE IS NO PUZZLE!

And here is the end of my LETTER TO THE EDITOR of NEW SCIENTIST of the 9 March 1987:

An old man, presenting himself as an eternal student, visited once Einstein late in the evening and drew the enigmatic figures shown above asking for the predictions of the maestro, but because of the late hour promising to pass for the answers the next day. This strange eternal student has, however, not appeared anymore, and Einstein, like Mozart after the visit of the old man ordering him a requiem, had have the feeling that he has been visited by the merciless fate.

Einstein, Maddox, Kurti and tutti quanti are puzzling when giving the third answer in the second experiment: Motion of loop and wire WITH RESPECT TO WHAT?!?!

PHYSICS ESSAYS

AN INTERNATIONAL JOURNAL DEDICATED TO FUNDAMENTAL
QUESTIONS IN PHYSICS

Editor:
E. Panarella

30 November 1989
PE1784/KLA

Dr. Stefan Marinov
Institute for Fundamental Physics
Morellenfeldgasse 16
A-8010 GRAZ
AUSTRIA

Re: Manuscript: ABSOLUTE AND RELATIVE NEWTON-LORENTZ EQUATIONS, by Stefan Marinov, submitted for publication in Physics Essays (received 9 March 1989).

Dear Dr. Marinov:

I received your letter of 15 November 1989 and am pleased to inform you that, based on the strength of your arguments and on the conviction that you have in your ideas, I am willing to accept your paper for publication in "Physics Essays".

However, as I mentioned in one of my previous letters to you, I am disturbed by the tone of the language that you use in your article. Such tone invites a reader to reject your arguments, rather than accepting them. For this reason, I cannot accept your paper unless it is written in the standard language adopted in the physics literature.

I have taken the liberty of indicating in the enclosed copy of your paper what I would like to see revised and how I would like to see the revisions.

I hope that you find my suggestions for revisions acceptable and modify the paper accordingly. Since I would like this process of revision to remain under a tight schedule, I would therefore like to have your revised manuscript, in triplicate, back to me by 28 January 1990 at latest.

As you see from the suggested revisions, I have not touched at all or modified the strength and/or the means of your mathematical and physical arguments. I have just revised the tone of your language in order to have your paper more easily accepted by the physics community. I hope you will offer me your cooperation in this process of revision and improvement of your paper. Thank you.

Sincerely yours,

E. Panarella

E. Panarella

EP/kla

c/o National Research Council, Rm. 100 Bldg. M10, Ottawa, Ontario K1A 0R6, Canada
Tel: (819) 770-0477, Fax: (819) 770-3862

Marinov's note. In a letter of the 19 December 1989 I thanked Prof. Panarella for his scientific courage by having accepted my paper for publication. I revised my manuscript exactly according to his suggestions. The revisions can be seen by comparing the article published in PHYSICS ESSAYS with the article published in TWT-IV, p. 101.

PHYSICS LETTERS A

PROFESSOR J. P. VIGIER
Université Pierre et Marie Curie
Centre National de la Recherche Scientifique
Laboratoire de Physique Théorique
Institut Henri Poincaré
11 Rue Pierre et Marie Curie
75231 Paris Cedex 05
France
Telephone (14) 336 2525 ext. 3776/82
Telex: UPMC Six 200 145 F

30/11/89

V1209a

Dear Dr Marinov

The response of the referee~~(s)~~ to your paper is negative (copy~~(ies)~~ enclosed). I regret that I am unable to accept your paper for publication and return your manuscript herewith.

Yours sincerely,

Vigier

J.P. VIGIER

I confirm the rejection of the following papers:
V727a, V791a, V726a.

Editorial note. Marinov's answer to the above letter is given in his letter of the 7 December 1989. The paper rejected by Prof. Vigier is published in TWT-IV, p. 118.

NORTH-HOLLAND PHYSICS PUBLISHING ★ P.O.B. 103 ★ 1000 AC AMSTERDAM ★ THE NETHERLANDS
Cables: ESPOM Amsterdam — *Telex:* 10704 espom nl — *Telephone:* 020 - 586 29 11

PHYSICS LETTERS A

Ref. Nr. V 1209 a

Comments on:

THE DEMONSTRATIONAL MULLER-MARINOV MACHINE
by Stefan Marinov

The Muller-Marinov machine is an ingeneous device intended to duplicate all the phenomena which can be produced with the Faraday disc, and homopolar machines in general. The M-M machine does not appear to reveal any new and unexpected effects. As the title of the paper indicates, Marinov proposes a demonstration for students. Whether this is of interest to readers of Physics Letters A has to be decided by the editor.

The operation of the machine as a generator is fully in accordance with Faraday's discovery. The induction of the e.m.f. depends solely on the relative velocity between the two parts of the electrical circuit. The relative velocity of the magnet with respect to either part of the electrical circuit does not influence the induced e.m.f., so long as the geometry of the magnetic field remains unchanged.

I do have a question regarding the operation of the machine as a homopolar motor. In the case of the Faraday disc, the presence of the magnet is essential for the generation of the motor torque. It is not clear to me, however, if the M-M machine really requires the magnet belt to produce relative rotation between shaft and sticks. My doubt arises from the fact that Marinov himself demonstrated the rotation of a "ball bearing motor" which did not posses an external magnet. Hence for the homopolar motor demonstration to be convincing, the author will have to show that the motor will not rotate when the magnets are removed.

There have always been problems with field theoretic explanations of homopolar machines. Most textbooks on electromagnetic theory avoid the problem altogether. Here Marinov could make an original contribution. Unfortunately he mixes field quantities, like the electric field intensity, with the action at a distance parameter of the magnetic vector potential (Aharonov-Bohm effect). He also fails to give clear definitions of the all important relative velocities.

It is an experimental fact that electromotive forces in metal do not produce mechanical (ponderomotive) forces. Therefore Marinov is wrong when he attributes a ponderomotive force to his equ.(1). This equation has the dimension of volts per meter, which does not involve 'newtons'.

PHYSICS LETTERS A

PROFESSOR V.M. AGRANOVICH

Institute of Spectroscopy
USSR Academy of Sciences
Troitsk
Moscow 142092
USSR

STEFAN MARINOV
Morellenfeldgasse 16
A - 8010 Graz - AUSTRIA

5 декабря 1989 г.

Глубокоуважаемый господин Маринов!

Честно говоря, я был несколько удивлен, снова получив Ваши статьи. Я полагаю, Вы понимаете, что мои возможности как редактора находить подходящих рецензентов для Ваших статей ограничены. Мне представляется, что свои ресурсы я исчерпал. Поэтому, мне кажется, Вам лучше впредь не направлять мне Ваших работ - я Вам помочь уже ничем не могу.

Я вижу, что Вы находите возможность публиковать свои статьи, и таким образом результаты Ваших работ доходят до человечества, о котором Вы так печётесь.

Желаю Вам доброго здоровья,

Искренне Ваш,

Профессор В.М.Агранович

Editorial note. With the above letter Prof. Agranovich answers Marinov's letter of the 25 June 1989 published in TWT-VI, p. 318.

NORTH-HOLLAND PHYSICS PUBLISHING ★ P.O.B. 103 ★ 1000 AC AMSTERDAM ★ THE NETHERLANDS
Cables: ESPOM Amsterdam — *Telex:* 10704 espom nl — *Telephone:* 020 - 586 29 11

STEFAN MARINOV
Morellenfeldgasse 16
A-8010 GRAZ — AUSTRIA

7 December 1989

Prof. J. P. Vigier
PHYSICS LETTERS A
Institut Henri Poincare
11 Rue Pierre et Marie Curie
F-75231 Paris Cedex 05

Dear Prof. Vigier,

Thank you very much for your letter of the 30 November, although the rejection of my paper V 1209 a entitled THE DEMONSTRATIONAL MOLLER-MARINOV MACHINE and the confirmation of the rejection of my papers V 726 a, V 727 a, V 791 a was, of course, not pleasant for me.

I do not accept the referee's criticism on my paper V 1209 a but I do not ask for a revision of your decision, as such a request, I am sure, will not receive satisfaction.

Nevertheless I present my objections to the referee's comments as I always do (at least for my own satisfaction).

I give my answers and comments to all 5 items of the referee.

1. The title of the paper does not show that the demonstrational Müller-Marinov machine is destinated only for students. It is destinated first of all TO THE PROFESSORS, as the professors do not know about the existence of the motional-transformer induction and for this reason the professors cannot explain why the effects on the rotating Faraday disk are such as they are. Thus, I think, my paper will be of interest for the readers of PHYSICS LETTERS. --- The referee writes that the Müller-Marinov machine does not reveal any new and unexpected effects. This is not true. If the referee has not read about the effects which I have observed and if I have only described the machine, asking whether when magnetic belt and sticks rotate together there will be electric tension induced in the sticks, the answer of the referee, surely, will be "no". On the other hand, for the case when the sticks are at rest and the magnetic belt rotates, the referee will predict induction of tension along the sticks. To show that my predictions are true, you, Prof. Vigier, can pose these problems to three of your referees who have not read my paper and the answer of at least two of them will be as I predicted above. Thus the Müller-Marinov machine does not demonstrate any new and unexpected effects only to persons who know what a motional-transformer induction is, but for persons for whom the effects depend only on the relative velocities of the body (as for your referee) the effects are strange and unexplainable.

2. Faraday has explained the induction of electric tension in a wire by the number of the "magnetic lines" which the wire cuts in a unit of time, and physics has accepted and DOGMATIZED Faraday's WRONG concepts. Faraday operates only with the notion "magnetic intensity" **B** and makes the calculation for the induced electric intensity from the formula

$$E_{mot} = \mathbf{v}\times\mathbf{B}, \qquad (1)$$

where **v** is the velcoity of the wire. But at the case of the motional-transformer induction, i.e., when the magnet moves and the wire is at rest, the formula for calculating the induced electric intensity is not (1), where for **v** the velocity opposite to the velocity of the magnet must be taken, but the following formula

$$E_{mot\text{-}tr} = (\mathbf{v}.\mathrm{grad})\mathbf{A}, \qquad (2)$$

and in this formula we do not see the magnetic intensity **B** but only the magnetic potential **A** produced by the magnet at the point of the wire's location.

When the magnetic belt in the Müller-Marinov machine is at rest and the sticks move, the induced electric intensity, obviously, will be calculated by formula (1). However when the sticks are at rest and the belt moves, which formula is to be used? Again formula (1)? Are not in this case the sticks cutting "magnetic lines" as in the first case? - Yes, they are cutting magnetic lines. But tension IS NOT INDUCED. Why? - Your referee cannot give an answer. Meanwhile in this case the induced intensity is to be calculated according to formula (2) and it shows that the induced in the sticks tension must be null.

The relativists think that in the second case tension is induced in the circuit but the tension induced in the sticks is equal and opposite to the tension induced in the cylinder (see fig. 1 in my paper) and for this reason no current goes through the galvanometer. Is the referee also thinking so? Yes, he surely is thinking so. But this is not true! Müller has done excellent experiments (see TWT-II, p.46) showing that in this case no tension in NO PART of the circuit is induced. However if we rotate sticks and cylinders TOGETHER, equal and opposite tensions will be induced in them (Müller has done the relevant experiments). Thus not the cutting of "magnetic lines" is from importance. And let me note that at the rotation of his cylindrical magnet about its axis Faraday once thought that the magnetic lines rotate with the magnet, once thought that they do not rotate, and more than a century after Faraday's death humanity cannot understand that there are no magnetic lines and that all effects in electromagnetism are to be calculated by the POTENTIALS and NOT by the intensities.

And which is the opinion of the referee? Will the magnetic lines rotate with the rotation of the magnetic belt or not? I know that your referee will not dare to give an answer as he does not know what to say. Meanwhile the answer is: There are neither magnetic lines nor magnetic intensity. The calculation in the first case is to be done not by formula (1) but by the formula

$$E_{mot} = \mathbf{v}\times \mathrm{rot}\mathbf{A}. \qquad (3)$$

And if magnet and wire move together, the calculation is to be done by the formula

$$E = E_{mot} + E_{mot-tr} = \mathbf{v}\times \mathrm{rot}\mathbf{A} + (\mathbf{v}.\mathrm{grad})\mathbf{A}. \qquad (4)$$

For this reason there IS induced tension in the sticks when sticks and belt rotate together. Meanwhile the relativists, in such a case, predict NO TENSION.

The referee and any professor and student can persuade himself that the above formulas are the right ones, and not the idiotisms of relativity, by observing the effects in the Müller-Marinov machine. But as the referee has rejected the publication of this paper, the relativistic idiotisms will be further taught in the schools and in the universities.

3. I especially noted that in my Müller-Marinov machine the ball-bearing rotational effect will be neglected. But the referee doubts whether the torque in my machine is electromagnetic, according to the theory presented by me, or it comes from the ball-bearing effect, as he is not sure whether the predicted by me electrodynamic motor effects exist. Well. My ball-bearings were of bronze (taken from old nazi torpedoes) which I have then gilded. Such ball-bearings have NO ball-bearing motor effect, as their surfaces are soft (see TWT-II, p. 101). When the magnetic belt is removed THERE IS NO TORQUE.

4. The referee writes:

> There have always been problems with field theoretic explanations of homopolar machines. Most textbooks on electromagnetic theory avoid the problem altogether.

You see, Prof. Vigier, the referee knows VERY WELL that something is rotten in the realm of conventional electromagnetism. Meanwhile, 12-years old children, operating with formulas (2), (3), (4) explain easily the induction and motor effects in all kinds of electromagnetic machines. And I try to explain to the world the essence of electromagnetism which my 12-years old pupils perfectly understand but the referee does not allow to me to appear before the world's scientific forum.

I do not mix anything and I sustain and show by experiments that the POTENTIAL electromagnetic interactions are DISTANT INTERACTIONS and are to be calculated only by the help of the electric and magnetic potentials and only IDIOTS can speak about the mystic "propagation of interaction". The magnetic potential plays the same PRINCIPAL AND DECISIVE role at the motional and motional-transformer inductions as well as at the Bohm-Aharonov effect. There is absolutely no difference in the treatment of the magnetic potential in classical physics and in quantum physics.

Then the referee asserts:

> Marinov fails to give clear definitions of the all important relative velocities.

Meanwhile anyone who has read my papers and books affirms that I am the most clear and exact physics writer in the world today.

5. In the last item the referee appears as a very BAD STUDENT. He asserts that with formula (1) one has to calculate only induced electric intensity which generates current but not kinetic intensity which generates ponderomotive push. Meanwhile the answer

is the following: if **v** in formula (1) is velocity of the wire, **E** is electromotive intensity, if **v** is the velocity of the charges in the wire, **E** is ponderomotive (kinetic) intensity. In the first case **E** has the dimensions "volt/m", in the second case **E** has the dimensions"newton/coulomb". My 12-years old pupils immediately can show that

volt/meter = newton/coulomb.

If the referee cannot make this transition, I am unable to help him.

When I read the comments of the referees of PHYSICS LETTERS, I am asking myself: Can Prof. Vigier not find referees for his journal between the students of the University P. et M. Curie with good notes on physics and mathematics?

Dear Prof. Vigier, I submit now to PHYSICS LETTERS A the following two papers (which I send in single copies, as I see that you send my papers only to one referee):

CALCULATION OF THE PUSHING FORCE WHICH ACTS ON THE AMPERE BRIDGE.

REPETITION OF WHITEHEAD'S EXPERIMENT FOR DEMONSTRATING THAT DISPLACEMENT CURRENT IS A PURE MATHEMATICAL FICTION.

I have only one plea to you. When sending my papers to a referee, ask him to send you a photocopy of his university dimploma and check whether he has good notes on physics and mathematics.

Hoping to receive your acknowledgement for the reception of this letter and then in due time also your decision on the submitted papers,

Sincerely yours,

S. Marinov

Stefan Marinov

<u>Editorial note</u>. Prof. Vigier acknowledged the reception of the above letter with his letter of the 11 December. At the date of giving this book for print no other letter has come from Prof. Vigier.

STEFAN MARINOV
Morellenfeldgasse 16
A-8010 GRAZ — AUSTRIA

8 December 1989

Prof. Robert Romer
AM. J. PHYS.

Merrill Science Bldg., Room 222
Amherst College
Amherst
MA 01002

Dear Prof. Romer:

Thank you very much for your letter of the 1 August 1989 which I received in due time, although the rejection of my paper "The demonstrational Müller-Marinov machine" was, of course, not pleasant for me.

I know VERY WELL the editorial policy of the AJP (in theory and in practice), as in the last 20 years I have submitted to the AJP about 100 papers.

Now I submit to your journal my paper

MAXWELL'S BIGGEST LIE: THE DISPLACEMENT CURRENT.

Concerning space-time physics the attitude of conventional physics and of the AJP is clear and definitive: light has the same velocity along all directions in a laboratory moving in absolute space and the absolute velocity of the laboratory can be not measured by carrying out experiments in the laboratory; neither a gravitational acceleartion can be distinguished from a kinematic acceleration experimentally. I affirm exactly the opposite and I have demonstrated this experimentally. Thus my space-time papers are to be rejected by your journal AUTOMATICALLY.

Now I submit NOT a space-time paper. My present paper is dedicated to the displacement current. Here the attitude of conventional physics and of the AJP are no clear and definite: is there a displacement current or is there not? - The assertion on Monday, Wednesday and Friday is "yes" and on Tuesday, Thursday and Satürday "no". On Sunday sometimes the assertion is "yes", sometimes "no".

I affirm on all days of the week that there is no displacement current. Thus now, according to the editorial policy of your journal, I hope, my paper will be not rejected automatically and you will send it to a referee.

If the paper will be accepted for publication, certain "sharp" and colloquial expressions can be substituted by more "soft" ones. The sentences where I speak about violations of the principles of relativity and equivalence and of the laws of conservation can be simply omitted. Also the citations in German can be given additionally also in English translations. And of course the title will be changed.

I beg you to acknowledge the reception of my paper and whether it will take the AUTOMATIC hurdle.

Sincerely yours,

Stefan Marinov

Editorial note. The above letter is answered by the Editor of the AM. J. PHYS. with his letter of the 2 January 1990.
The above mentioned paper under the title MAXWELL'S ILLUSION: THE DISPLACEMENT CURRENT is published in the present volume (p. 40).

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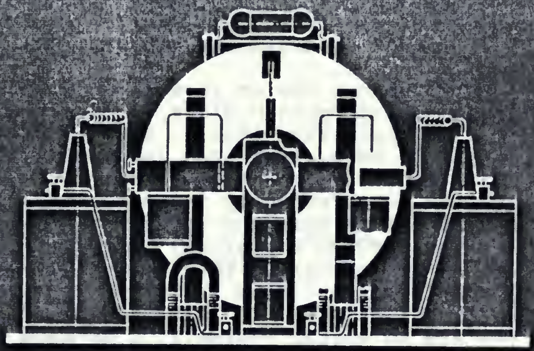

DIFØT arrangerer foredrag med fysikeren

STEFAN MARINOV

Tirsdag den 12. december 1989 kl. 19.30

Københavns Universitet, Amager, Njalsgade 80, Aud. 15.1.30A

Entré 30 kr.

Foredraget holdes på engelsk

Den bulgarsk fødte fysiker Stefan Marinov bor nu i Graz, Østrig, hvor han på eget initiativ fører en utrættelig kamp for at udbrede kendskabet til den fri energis muligheder for at løse verdens energiproblemer. Hans kontroversielle teorier om energi og stof har mødt megen modstand inden for den etablerede fysik.

GALILEAN ELECTRODYNAMICS
Box 251
Boulder, CO 80306
tel. 303-444-0841

16 December 1989

Dear Dr Marinov:

Many thanks for your letter of 8 December. You are right, I received your papers and did not acknowledge them. But then, I am being showered with papers and I acknowledge nothing (until reviewers force me into a definite refusal or acceptance), because I am doing the whole thing myself, including printing and binding, with no help whatsoever and on a shoe string -- you probably know the situation. I have to be impolite to get anywhere at all. And I did -- the first issue went out a few days ago (the foreign "Printed Matter" mail even earlier). Things are not helped by the fact that this week I have to undergo an operation from which it will take some time to recover.

Now about your papers. I must tell you quite frankly what the trouble is. All five papers that you have submitted describe and refer to your experiments. But I have been told by some of your former friends that these experiments are in fact only thought experiments, that you have never performed them, and one of your former friends even claims that you have admitted as much.

Since I know neither you or them personally, and have not fully heard the story from both sides, I cannot and will not make a judgement on the accusation itself. However, since your experiments have not been replicated (even Silvertooth's experiment takes good care not to have any moving parts on the table on which the interferometry is performed), I must at least consider the possibility that the accusation could be true, and the risk of ridicule -- on top of all the other risks -- is one that a beginning new journal in this "maverick" class simply cannot take, and I will not take it, or at least not until long after it is well established.

Since you are an editor yourself, I do hope you will understand my position.

Is "TWT" still being published? If so, I would like to subscribe to it.

I was also very pleased that you are an old friend of the Czech people, as proved by your expulsion in the 70s. I am, naturally, very elated by recent events.

With best wishes for Christmas and the coming New Year,

Yours sincerely,

Petr Beckmann

Petr Beckmann

Editorial note. Marinov answers this letter with his own of the 16.I.1990.

THE GOLEM PRESS
Box 1342
Boulder, CO 80306

DENVER, CO 802
PM
18 DEC
1989

AIR MAIL

USA 20

DR STEFAN MARINOV
MORELLENFELDGASSE 16
A-8010 GRAZ
AUSTRIA

If you value authority higher
than the experimental evidence,
DON'T BOTHER to open this letter

Einstein-Laboratorium für Theoretische Physik
der Akademie der Wissenschaften der DDR
Direktor AkM Prof. Dr. [illegible] mult. H.-J. Treder

Herrn
Dr. Stefan Marinov
Morellenfeldgasse 16
A-8010 Graz
Österreich

1506 Caputh, den 19. 12. 1989
Am Waldrand 15/17

Sehr geehrter Herr Dr. Marinov,

anbei Ihr Manuskript "The Myths in Physics" zurück. Ich bitte Sie, meine Mitarbeiter und mich nicht mehr durch Ihre Zusendungen zu beehren.

Hochachtungsvoll

Prof. Dr. Dr. H.-J. Treder

Sekretariats-Anschrift: Akademie der Wissenschaften der DDR · Einstein-Laboratorium
Rosa-Luxemburg-Straße 17 a · Potsdam 1590

1/16/46 FuG 037/39/89

Translation.

Dear Dr. Marinov,

herewith I send you back your manuscript "The Myths in physics". I beg you no more to honour my collaborators and myself with your submissions.

Sincerely yours,

Prof. Dr. Dr. Dr. Dr. H.-J. Treder

Editorial note. The above paper is published in TWT-III, p . 59.

STEFAN MARINOV
Morellenfeldgasse 16
A-8010 GRAZ — AUSTRIA

Tel. 0316/377093

23 December 1989

Dr. John Maddox
NATURE
4 Little Essex Street
London WC2R 3LF

Dear Dr. Maddox,

When I was in London in December 1988, you promised me that your "Christmas puzzle" dedicated to the Kennard and quasi-Kennard experiments will appear on the 22 December 1988 in NATURE. It has not appeared. You promised me on the phone to publish it in the first weeks of January, then in the last weeks of January, then in February, then in March, then as an "Easter puzzle", then as a "Whitsun puzzle", then as a "Corpus Christi puzzle", then as an "Assumption-Day-puzzle", then as "All-Saints-Day-puzzle".

Finally, when the year 1989 came to its end, you promised solemnly that the Christmas puzzle for the scientific year 1988 will appear as a Christmas puzzle for the year 1989 on the 21 December. In November you said me on the phone that you have sent by post the composed text of the puzzle, so that I can publish it in the seventh volume of TWT which had to be given to the printer for the first Advent day. Your letter did not come and you said me that you will post the text a second time. Neither the second letter came. Then you promised to send the text by fax. During the whole December your promises in our every-day phone conversations were: "The text will be faxed this afternoon, tomorrow morning, today before 12.00. etc." But the fax never came.

On Monday, the 18 December, you asserted on the phone that the puzzle will appear on the 21 December. You confirmed this assertion on the 20 December (on the 19 December you were ill) when NATURE was already printed. Finally, on the 21 December you said that the puzzle will appear on the 4 January 1990.

As you see, I do not lose my psychic equilibrium and continue to phone you every day once, twice, thrice and even four times a day. My phone calls to you in the last 10 years have surely overpassed the number 1000. Which is your opinion? - Are they more than 1000 or less than 1000?

Why I do not lose my psychic equilibrium? - Because I know that you finally will publish your puzzle, and you will publish my discussion with Tiomno, and you will publish the big paper which is with Mr. Wenz composed and ready for print since my visit in June 1988.

The scientific truth, Dr. Maddox, can be suppressed by "securitate"-methods only for certain time, not for ever.

You said me yesterday on the phone that you have not published the puzzle on the 21 December as you were not satisfied with the presentation and you wish to write a new text. That's very good! I said you that I shall help you, so that in the last minute you can jump from the Einstein train on Marinov's train and appear before the world as one of the cleverst physicists.

I send you the paper of W. Rindler published in the AM. J. PHYS., **57**, 993 (1989), my letter to the editor of the AM. J. PHYS., and my additional comments. Read all these materials attentively (read only the first two sections in Rindler's paper, as the other two are a pure schizophrenia). Then write your puzzle not as a puzzle but as a paper of a man who finally has understood all these trivialities which my 12-years-old pupils perfectly well and without any efforts understand.

I am awaiting to receive by fax the composed text of your no more "puzzle" but "revelation" in the first days of January and to see the paper published in the 4-January-issue. I shall give my TWT-VII for print on the 8 January and I hope to have your faxed text before that date.

I have endured years to hear your every-day false promises. And I was always aimable and kind to you as, I must confess this, you also were. I hope that finally you will reward my loyalty and friendship with deeds.

Be clever and send me £ 60 in cash in a registered letter, so that I send you volumes V, VI and VII of THE THORNY WAY OF TRUTH. You can see there <u>amazing things</u>.

Wishing you a happy New Year,

Yours: [signature]

ANNALS OF PHYSICS

Publisher:
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Harcourt Brace Jovanovich Building
1250 Sixth Avenue
San Diego, California 92101

December 26, 1989

Dr. Stefan Marinov
Morellenfeldgasse 16
A-8010 Graz, Austria

Dear Dr. Marinov:

I am sorry to have to inform you that the editorial board has decided not to accept your manuscript, "Violations of the Laws of Conservation of Angular Momentum and Energy," which you kindly submitted to the ANNALS OF PHYSICS. The number of pages that ANNALS publishes each year is limited and the number of papers submitted is increasing considerably. We find no evidence that your paper is incorrect, but must reject it on account of limited space.

Thank you for having considered us for this paper, which we are returning to you enclosed.

Sincerely,

Herman Feshbach/eos

Herman Feshbach
Editor

HF/eos
Reference 62291
Enclosure

<u>Marinov's note</u>.

Dear Herman, you found no evidence that my paper is incorrect and nevertheless you declined publication. Meanwhile in my paper I report on violations of the laws of conservation and if my report is correct, then this is the biggest discovery in physics. Thus I remain perplexed which noble animal to stick on your letter: the frog or the ass, the frog or the ass? - Oh, yes - BOTH.

AMERICAN JOURNAL OF PHYSICS

Robert H. Romer, Editor
Mark D. Semon, Assistant Editor
Karla Keyes, Assistant to the Editor

Merrill Science Building, Room 222
Box 2262
Amherst College
Amherst, Massachusetts 01002

(413) 542-5792

January 2, 1990

Dr. Stefan Marinov
Morellenfeldgasse 16
A-8010 GRAZ
AUSTRIA

Dear Dr. Marinov:

After carefully studying your manuscript, "Maxwell's Biggest Lie: The Displacement Current" we regret to inform you that it is not appropriate for publication in the American Journal of Physics. As stated in our Statement of Editorial Policy, published in the January issue of each year, AJP can only consider for publication papers dealing with concepts accepted by the general community of physicists. New ideas, theories, and speculations must first appear and be debated in journals devoted to the frontiers of current research. Since the material presented in your manuscript falls into this category we cannot consider it for publication, and we advise you to seek a more appropriate forum.

Sincerely yours,

Mark D. Semon

Mark D. Semon

Editorial note. This is an answer to Marinov's letter of 8 December 1989. The above mentioned paper is published on p. 40 of this book.

ACTA PHYSICA POLONICA
Reymonta 4
30-059 Kraków, Poland
tel. (48-12) — 33 63 77 ext. 574

Kraków, dnia 2. 01,1990

6/90

Dr Stefan MARINOV
Institute for Fundamental Physics,
Morellenfeldgasse 16
A-8010 GRAZ, Austria

Dear Dr Marinov,

your paper "Physical Essence of the Maxwell- Lorentz Equations" has been rejected. I wish to remind you that the decision of the Editorial Committee to stop all correspondence with you is final.

Sincerely yours

/Prof. dr Andrzej Staruszkiewicz/

AMERICAN JOURNAL OF PHYSICS

Robert H. Romer, Editor
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Dr. Stefan Marinov
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January 9, 1990

Dear Dr. Marinov:

I write in connection with your recently submitted Letter to the Editor "Relativity and Electromagnetism". I have explained to you before that we are not interested in publishing papers that criticize or attack well-established theories such as relativity and Maxwell's electromagnetism. Such papers are more appropriately submitted elsewhere, and this has been explained to you before. It is also stated clearly in our Statement of Editorial Policy.

You seem to take great pleasure in having your papers turned down by AJP. In the future, if you choose to continue to submit inappropriate manuscripts to this Journal, that is something you are of course free to do, but you must not expect me to spend further time acknowledging papers that you know to be inconsistent with our editorial policy.

Sincerely yours,

Robert H. Romer

Editorial note. Marinov answers this letter with his own of 26 February 1990.

STEFAN MARINOV
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16 January 1990

Dr. Petr Beckmann
GALILEAN ELECTRODYNAMICS
Box 251
Boulder
CO 80306

Dear Dr. Beckmann,

Thank you very much for your letter of the 16 December 1989, although, I must confess, the rejection, or, better to say, the "temporary ban" of my submitted papers was not pleasant for me.

My papers are put under such a "temporary ban" not only in your journal. Other journals which have done the same are: NATURE (Dr. Maddox), where the COMPOSED paper can be seen in TWT-III, FOUNDATIONS OF PHYSICS (Dr. van der Merwe), JOURNAL OF PHYSICS (Mrs. L. Richardson), PHYSICS LETTERS (Prof. J. Vigier), NUOVO CIMENTO (Prof. R. Ruffini). The rest of the physics journals in the world either do not wish that I submit papers to them or systematically reject my papers or do not answer my letters at all (see the relevant documents in TWT).

Before to begin publishing my papers, you (as well as the above mentioned editors) wish to know whether my experiments have been done indeed and whether they have given the results reported by me which seem to be very strange. I think that this can be established ONLY BY PUBLISHING MY PAPERS. If my papers remain unpublished, then only rumours can circulate in the world (they circulate since 15 years) that my experiments have been not done. But rumours create only confucion, nothing else. So you write:

> I have been told by some your former friends that these experiments are in fact only thought experiments, that you have never performed them, and one of your former friends even claims that you have admitted as much.

If, however, I should ask that you tell me the names of these my "former friends", you will not divulge them. Can science prosper in this way? Is this a scientific GLASNOST?

On the other hand, almost all my experiments are CHILDISHLY SIMPLE. You know very well that I earn my bread as a groom and that I finance my whole experimental, theoretical, editorial and organizational activity by my OWN MONEY. No scientific institution in the world has given me during whole my life a single cent. Thus, as my experiments are so simple, is it no more logical to publish the reports on my experiments and to address all my present and former friends and adversaries with the invitation: show whether Marinov's experiments are right or wrong? - Physics is neither theology nor arts. In physics there is an undisputable judge who decides who is right and who is wrong: the experiment. And this affirmation is also the leading maxim of your journal.

But experiments can be repeated and evaluated only if the information on these experiments is available. And when even your journal rejects to disseminate the information on experiments contradicting deep-rooted wrong physical concepts, then WHO ELSE WILL DO THIS?

The experiments of my Swiss friends have led to the construction of a PERPETUUM MOBILE. But although I dedicated a whole book (TWT-V) to this machine, the scientific community and the world still do not know about it, and these people who have heard say: "This cannot be true; Marinov's experiments and the experiments of Marinov's friends can be only Gedankenexperiments." To show that the machine TESTATIKA is a really existing eternally rotating machine, I addressed Dr. Maddox with the invitation to visit it. In the case that he will then publish in NATURE a photograph of him in front of the machine with a declaration that, ACCORDING TO HIM, TESTATIKA is NOT a perpetuum mobile, I shall pay him £ 10,000 Dr. Maddox answered that in a proper time, WHEN HE WILL HAVE A TRIP TO SWITZERLAND, he would be glad to see the machine. With the same proposal I addressed then Dr. Marchuk, the President of the Academy of Sciences of USSR, stating that BEFORE HIS TRIP I shall gladly deposit $ 20,000 in the Soviet Embassy in Vienna. Dr. Marchuk did not even answer my THREE letters and one telex. My invitation to the Nobel committee was also declined. All these stories are well documentd in TWT.

THE THORNY WAY OF TRUTH (TWT) is not a journal. Those are unregularly published books of some 300 pages with papers and documents dedicated predominantly to my research but I publish also papers of other persons working in the same domain. You can order any of the volumes by sending $ 25 in cash in an envelope (+ $ 5 for air mail). I shall be very glad to receive your journal, if you can send it to me free of charge. If not I order only the first issue. Hoping to hear soon from you,

Sincerely yours, S. Marinov Stefan Marinov

FRANCISCO MOLLER
8470 SW 33rd Terr.
Miami
FL 33155, U.S.A.

Miami, Jan.16th, 1990.

Stefan Marinov
J.Paul Wesley
Panos Pappas.

My dear friends in non-relativistic Physics:

*Undoubtedly you must think that I have forgotten our scientific ties. Well, Panos Pappas, who visited George Curé and myself in Miami last August can witness that that is not the case. My last correspondence with Marinov and Wesley dates back to Nov. and Dec. 1988 respectively, more than a year ago! But I keep you always in my mind. I give my thanks very much to Marinov for his words respect my work at the Peruggia*meeting, (Curé told me about it). What happens is that two years ago I started working towards my master in Physics. Once I achieved the rectilinear version of my induction experiments, as reported in Marinov's TWT-3, pg.271,(Fig.2), I felt strong enough (in my non-relativistic convictions), to go to the establishment and finish my Master in Physics without the danger of being brainwashed into relativity. This decision was also prompted by a critical condition at the Lab were I work, (the boss is retiring in 2 years and the grant might not be renewed). So I want to be prepared to "jump" to full time Physics. On the other hand I need to gain more background in Mathematical methods, Quantum Mechanics, etc. I go very slowly (only one subject each semester, ie., 3 credits), for a total of 30 credits, 6 of which can be thesis work. I intend to use my non-relativistic induction experiments for the Thesis. I might have a frontal collision with the establishment here, or maybe not. I think that the dissident movement in Physics is moving as fast as the political one in Eastern Europe. We had a meeting at St. Petersburg, Florida, last Dec.28th, (7 Florida dissidents altogether) and one of them, Bryan Wallace, reported about his visit to Leningrad last summer. It seems that now the relativists are under discrimination instead of the anti-relativists! Perestroika is doing this in some quarters in Russia. There is even a TV program called "Mirror" in Chapigina 6, Leningrad, that accepts public discussions questioning "Is Einstein right?". So maybe the USSR gets ahead of us and U.S. in breaking the Berlin Wall of Relativity.*

The newest advance that I know of in the U.S. is the journal Galilean Electrodynamics. Petr Beckman called me personally by phone to suggest that I submit an article about my experiments which he read in Wesley's Space-time Physics 1987. (A few scientists have also written me concerning my article in the Wesley book. I owe this to Paul). So I am rewriting some of my material, as usual combining the historical backgrounds with my magnet and wires experiments. I will emphasize the rectilinear version mentioned above which I discuss briefly for you in the next page. I am also grateful to Panos for the suggestion of repeating the experiment using an intermediate situation between that of Fig.1B and Fig.2, ie. keeping only <u>*one*</u> *of the semicylindrical magnets (labeled as ½CM in Fig.1B);details in the next page.*

With some shame for being so late, however, I desire you have a beautiful year of 1990. Let's all push in the same direction to see if within this decade the "wall" finally falls.

Yours as always, your irregular but faithful friend, Francisco Moller

* Perugia

Figs. 1A and 1B are the ones appearing in my abstract of 1988 (Marinov, TWT-3, pg.271). The idea of introducing the rectangular magnets RM1, RM2 in between the half cylindrical magnets, ½cm, was to be able to repeat my rotational induction experiments but in a straight line motion. The system of Fig.1B, (which is magnetized perpendicularly to the paper), could be moved continuously as indicated by the arrows if it were flexible, (like and endless magnetized belt). This is not possible with the solid ceramic magnets that I use. So the only thing we can do is to slightly displace the RM's as indicated in Fig.1C. Each magnet moves $\frac{1}{2}\Delta x$ to the left or the right in oscillatory fashion. The slight distorsion of the gaps is of no consequence. Stacking several layers of magnets as shown in Fig.3 the circuit RIEC can be inserted as usual. Then the "yoke" is added, (steel plates f,g,h,k in Fig.4) so that only branch IR is immersed in a magnetic field B while ECR lies in a B=0 region.

As you recall, when sliding contacts are introduced at R (and also at I) there were 8 possible combinations of relative motion between IR, ECR and the magnets. The resulting emfs, (indicated by E) are shown in Table I. If you compare these results with my Tables for the rotational experiments you will see that they are identical!

TABLE I

	Motion of:			Resulting emf's:	
	IR	ECR	Magnets	Fig.4	Fig.2
1)	o	o	o	0	0
2)	v	o	o	E	E_+
3)	o	v	o	0	0
4)	o	o	v	0	E_-
5)	v	v	o	E	E_+
6)	v	o	v	E	0
7)	o	v	v	0	E_-
8)	v	v	v	E	0

v=linear motion *E=observed emf*
o=rest(relative to the Lab) *0=no net emf*

As in rotation, case 8 (and 6), violate the requirement of relative motion. But since we are dealing now with linear motion (v), there is no subterfuge into General Relativity to save the theory. (Motion of ECR and magnets are irrelevant). Also, motion of the yoke alone becomes irrelevant (in contrast with rotation of the yoke).

The kinematically reciprocal pairs of cases, (1-8, 2-7, 3-6 and 4-5), do not yield identical results, again contrary to special relativity.

But consider now the situation of Fig.2 in which the ½cm's are removed (and, of course, remain under the yoke as in Fig.4). Then the results change dramatically for cases 4,6,7 and 8. These now agree with relativity! Why? Because the newly created (short) rectangular edges of the magnets introduce -vxB effects, (due to $(v.\nabla)B$) that now render relevant the motion of the magnets. (Their motion yields E- if v in the Table is always taken in the same direction.

Relativistic electrodynamics can predict the results for Fig.2 through the field transformation equations. But then these same transformations fail for Fig.4. Hence the contradiction.

There is nothing in relativity theory to account for the effect of the edges. In fact, no local field theory can account, either, for inductions at RI as influenced (even cancelled!) by v.∇ effects at the edges, far removed from RI. Note that the intensity of B=∇xA is practically constant throughout most of the length of the magnet, regardless of the presence, abscence or distance of the edges. So the edge effect in Fig.2 (which is what cancels the vxB at RI) will not disappear even if the magnets are "long enough", (contrary to what Marinov predicts in TWT-3 commenting my abstract). If they disappeared then the surviving vxB would allow us to detect the absolute linear motion of the system (together with the earth!), contrary to observed facts.

Let me emphasize:

Unipolar induction, that is: induction in a wire comoving with the magnet-source-of-the-field in which the wire is locally immersed, is only possible when the magnet's motion introduces no (v.∇)B, (or no (v.∇)A as Marinov writes), anywhere in the Universe. Such is the case in a rotating magnet (Fig.1A) or continuous "belt" (Fig.1B). Linear translation of the whole system always entails v.∇ effects at the round edges of the cylindrical magnets, (just as pernicious as the short edges of the RM's in Fig.2).

A beautiful confirmation of the edge effect was obtained when, following a suggestion of Pappas, I removed only <u>one</u> ½CM from Fig.1B. The results were qualitatively identical to those of Fig.4, Table I, but with exactly HALF the intensity of emf's for each observed E. Pappas asserts that the short edges in Fig.2 imply extra amperian equivalent magnetization currents along those edges, (absent in Figs.1A and B). I do not know how these extra currents can affect RI to give the E- of Fig.2, Table I.

I think we still need a theory to explain the dramatic contrasts between Figs. 2 and 1B(=Fig.4). A challenge, indeed, for both relativists and non-relativist physicists!

MARINOV'S COMMENTS TO THE ABOVE LETTER OF F. MOLLER

I can only repeat my comments which I attached on p. 270 of TWT-III to Müller's letter of the 20 February 1988: All effects in his experiments can be easily explained by my formulas of the induced motional and motional-transformer electric intensities.

Müller writes: "Note that the intensity **B** = rot**A** is practically constant throughout most of the length of the magnet, regardless of the presence, abscence or distance of the edges." THIS IS TRUE! But the electromagnetic induction (as well as ALL electromagnetic effects!) are determined NOT by the magnetic intensity B BUT BY THE MAGNETIC POTENTIAL **A**. And presence or abscence of the half-cylindrical magnets (1/2)CM changes DRASTICALLY **A** at the points of location of the wire IR (two half-cylindrical magnets change **A** twice as much as one!). Thus if the rectangular magnets RM_1 and RM_2 are very long, the magnetic potential at the points of location of the wire IR becomes quite the same as at the presence of the half-cylindrical magnetcs (1/2)CM. Proceeding from this conclusion one can, of course, detect the absolute linear motion of the system as I did (see TWT-IV, p. 110). Two students (in Holland and Italy) have repeated my experiment and have also observed anisotropy effects. Emidio Laureti (from Rome) visited Prof. Bartocci's conference in Perugia in September 1989 and informed the audience about his experiment. Müller presents the objection that such effects have been observed by nobody. The answer is only one: My childishly simple experiment was done only by me, by the two students and BY NOBODY ELSE.

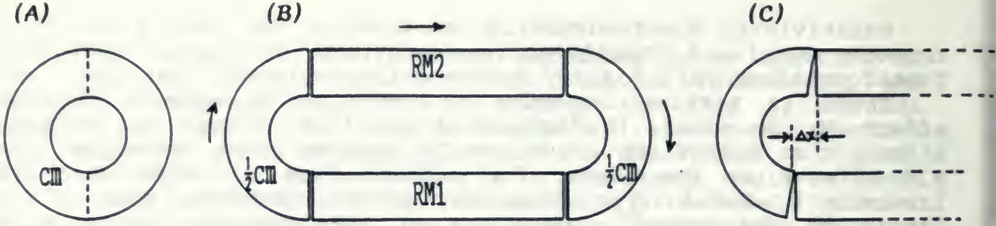

FIGURE 1

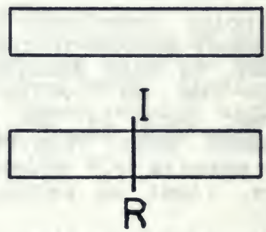

FIG.2

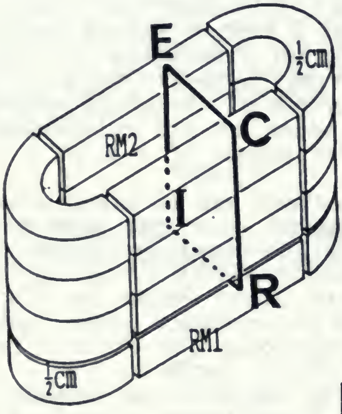

FIG.3

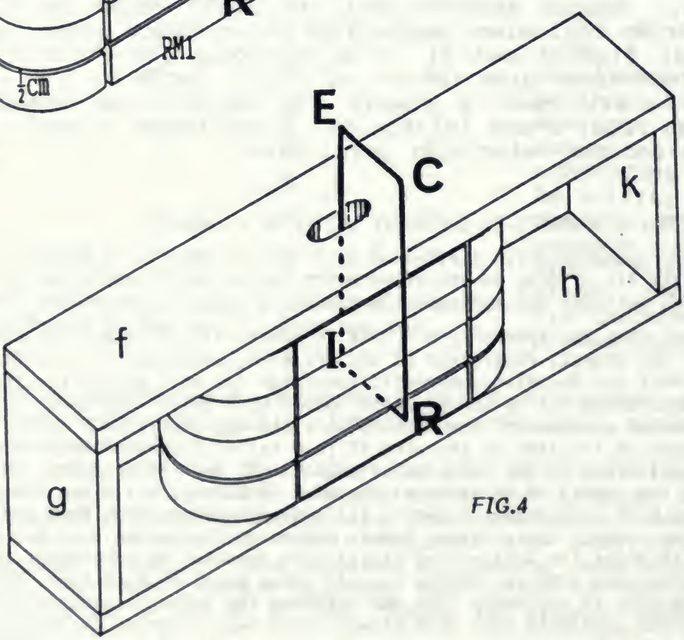

FIG.4

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26 February 1990

Prof. Robert Romer
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Amherst, MA 01002

Dear Dr. Romer,

Thank you very much for your letter of the 9 January 1990.

In my Letter to the Editor "Relativity and Electromagnetism" sent to you on the 20 December 1989 (and published on p. 221 of the seventh volume of my collection of documents THE THORNY WAY OF TRUTH - photocopies of the pp. 221 and 222 are enclosed) I pointed out that Prof. Rindler asserted in your journal that if a magnet moves with a velocity **v** with respect to a piece of wire where the magnetic intensity generated by the magnet is **A**, then the electric intensity induced in the wire will be not

$$\mathbf{E} = - \mathbf{v}\times\mathrm{rot}\mathbf{A} \qquad (1)$$

as it is commonly accepted in today's physics but

$$\mathbf{E} = (\mathbf{v}.\mathrm{grad})\mathbf{A}. \qquad (2)$$

I pointed out in my Letter that this formula was already deduced by me,besides in many of my books, also in two PAID articles in the prestigious journals "Nature" and "New Scientist". Thus I begged you to inform the scientific community that formula (2) is NOT Prof. Rindler's formula but MY formula.

I am sure that Prof. Rindler knows that (2) is my formula but I have no written documents for sustaining this assertion. Thus I am compelled to ASSUME that Prof. Rindler might be unaware of my publications and that he has deduced formula (2) alone for which he deserves all my congratulations.

But by rejecting to publish my Letter to the Editor, where I turn Prof. Rindler's (and of the whole scientific community) attention to my publications, you do something VERY UNCLEAN: you try to conceal the scientific truth. I insist that my Letter to the Editor should be published!

I send a copy of this Letter to the Editor, of your letter to me of the 9 January and of my present letter to Prof. Rindler, begging him to suggest to you that you publish my Letter to the Editor in the AJP.

If this will be not done, I shall have then the full right to accuse Prof. Rindler and the AM. J. PHYS. of SCIENTIFIC PIRACY.

Excuse me that I answer your letter with a certain delay. The reason is that I wished to finish my direct and inverse Rowland experiments reported in the paper

CHILDISHLY SIMPLE EXPERIMENT VIOLATING THE PRINCIPLE OF RELATIVITY

which is enclosed. If you will publish my Letter to the Editor, then I submit this paper to the AJP, so that Prof. Rindler, you and the whole scientific community can understand that relativity is dead.

I shall be happy then if, after the publication of my paper in the AJP, you will begin to reject the nonsensical papers of the so-called relativists and will do all efforts to cure the terrible aberrations in the minds of the college professors all over the world after 50 years of false indoctrination from the pages of the AJP.

Nevertheless I should like to note that I consider the AJP as one of the BEST physics journals in the world, as it always has tried to explain physics by a clear, simple and rigorously logical approach. Finally one cannot blame the AJP of having published during 50 years relativistic nonsense, as the whole scientific community accepted this nonsense as truth. But if now you will not publish my Letter to the Editor and then my article, every one will have the right to accuse the AJP in suppression of scientific truth and in trying to seminate scientific lies. But you know well, Dr. Romer: lie has short legs!

Hoping to receive an acknowledgement for the reception of this letter and then in due time also your final decision,

Sincerely yours,

Stefan Marinov

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27 February 1990

Dr. John Maddox
NATURE
4 Little Essex Street
London WC2R 3LF

Dear Dr. Maddox,

Let me make a short recapitulation of our mutual contacts in the last time. You remember all events VERY WELL, but I do this for posterity, as I have not registered our phone conversations (and if I have?!).

During my fifth visit of your office in London in December 1988 you promised to publish your "Christmas puzzle" (on the Kennard and quasi-Kennard experiments) on the 22 December 1988. In a whole year of phone conversations (2-3 times a week) you postponed the puzzle from Christmas to Easter, then to Whitsun, then to All Saints' Day, etc., but it never appeared. I was ready for print with the VII-th volume of THE THORNY WAY OF TRUTH on the 5 December 1989. As you promised me solemnly to publish finally the Christmas puzzle for the scientific year 1988 on the 21 December 1989 as a Christmas puzzle for the scientific year 1989, I decided to postpone the print of my book until you will compose the puzzle and send it to me by fax. Beginning from the 5 December 1989 until the 22 February 1990 I phoned you EVERY DAY (sometimes two or three times a day), as in this period you did not leave London, to hear your eternal promises that "I just am sitting over the text", "I am composing the text", "The text will be faxed in one (two, three) hours", "I shall phone you at 10 PM to say you that the text is faxed", etc., etc. or your blunt lies: "The text is sent by letter". Especially in February our contacts became very intensive and we spoke on the phone not only during the day but also in the tard night and even you called me a couple of times to confirm your false promises. In January I sent you also my Letter to the Editor "Relativity and Electromagnetism" which was rejected by the AM. J. PHYS. and you promised to publish my letter in the same issue with your famous "puzzle".

Our last phone conversation was on the 22 February at noon when you said me that at 2 PM you will call me to confirm when the text of your article will be faxed. As your call did not come, I phoned at 3 PM and Miss Mary said me that you just have left for the States. Such a trick you played already many times and always when we spoke after your arrival back to London, I cheered your return by the words: "Welcome, Dr. Maddox, from Washington (South Africa, Australia, Switzerland) etc."

I really cannot explain by a normal human logic why you play so many years this dirty play. Here are certain reasons: 1) to block the publication of my book by false promises, 2) to clutch me through the phone apparatus, so that I can neither do experiments nor write papers, 3) to ruinate my finances (when paying the fee for the phone) and to accelerate in this was my death by letting me starving, etc. But none of these alternatives seems to be tenable, so that the real puzzle is not your Cristmas puzzle. THE REAL PUZZLE ARE YOU! Yes, you, Dr. Maddox! - How can the editor of NATURE, a noble and fine man as you, behave himself in such an abhorrent way!? And I shall not leave you before I have unriddled the puzzle "Dr. Maddox". I am excited by your strange personality. Are there some reasons for your filthy behaviour (pressure from the relativistic lobby, from the Jewish community, from the oil-sheiks - because of the perpetuum mobile) or simply you are a clinic lier, who finds spiritual satisfaction by lying, as other persons find it by revealing the scientific truth, by riding horses or loving women? - Thus I beg you when you return from the States on the 6 March to call me. If you will not do this, then on the 7 March at noon you will hear the well-known: "Welcome from Washington, Dr. Maddox.

I gave my book for print. You delayed its publication with almost 3 months. But if you think that by lies and similar dirty tricks you will be able to save relativity, you make a big error! The scientific truth has an experimental support and it can be not silenced. I gave you so many materials, so that you can jump at the RIGHT moment at the RIGHT train. I see that you still hesitate. But there is no more time for hesitation. You have to decide on which train will you put foot: on Einstein's or on mine. I said you that after the publication of the puzzle I shall send you the report on a childishly simple experiment showing that the principle of relativity is wrong. Here it is:

CHILDISHLY SIMPLE EXPERIMENT VIOLATING THE PRINCIPLE OF RELATIVITY.

Please, acknowledge BY LETTER its reception and write me whether you will reject, examine or publish it. As you surely will be not satisfied with the last version of your "puzzle", write it again.

Yours: S. Marinov

CHILDISHLY SIMPLE EXPERIMENT VIOLATING THE PRINCIPLE OF RELATIVITY

Stefan Marinov
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Abstract. I give the report on an electromagnetic experiment which is not symmetric: when a charged body is moved with respect to a magnetic detector, there is an effect, however when the magnetic detector is moved with respect to the charged body, there is no effect. The principle of relativity predicts for these two cases the same effect.

1. INTRODUCTION

According to the principle of relativity, if there are two bodies A and B at rest in the laboratory that can be considered as isolated from other bodies, then the effects which will appear when the bodies will begin to move one with respect to the other depend only on the relative velocity of the bodies. Thus it must be of no importance whether the body A will begin to move, while the body B will remain at rest, or B will begin to move, while A will remain at rest: all effects which will be observed must be the same. This postulate of conventional physics is called principle of relativity.

According to my absolute space-time theory, the principle of relativity is not true, as the electromagnetic effects depend on the absolute velocities of the bodies. Consequently it is possible that the appearing effects for a motion of A will be not the same as for the motion of B.

2. THE ABSOLUTE AND RELATIVE NEWTON-LORENTZ EQUATIONS

In electromagnetism there are only two fundamental equations which cannot be deduced from other more simple postulates. Those are the laws of Coulomb and Neumann which assert that if there are two electric charges q_1, q_2 moving with velocities $\mathbf{v}_1$, $\mathbf{v}_2$, then they have two kind of energies, called electric (space) and magnetic (space-time) energies (the itilicized words here and beneath are my terms)

$$U = q_1 q_2/r, \qquad W = q_1 q_2 \mathbf{v}_1 . \mathbf{v}_2/c^2 r, \tag{1}$$

where r is the distance between the charges and the formulas are written in the CGS-system of units.

Using the law of superposition (the energy of a system of more than two charges is the sum of the energies of all its pairs) and putting (1) in the law of conservation of energy $dE_0 + dU + dW = 0$, where E_0 is the sum of the time energies $e_0 = mc^2(1 - v^2/c^2)^{-1/2}$ of any of the particles of the system, m being the respective particle's mass, I showed[1,2], by rigorous mathematical arguments, that one can obtain the fundamental equation in electromagnetism (called by me the Newton-Lorentz equation) and from it all electromagnetic "laws". I obtain this equation in the form

$$(d/dt)(\mathbf{p}_0 + q\mathbf{A}/c) = - q\,\mathrm{grad}(\Phi - \mathbf{v}.\mathbf{A}/c), \qquad (2)$$

where $\mathbf{p}_0 = m\mathbf{v}(1 - v^2/c^2)^{-1/2}$ is the momentum of a particle with electric charge q at a reference point where the electric and magnetic potentials of the surrounding system of n particles (summation from 1 to n) are

$$\Phi = \sum q_i/r_i, \qquad \mathbf{A} = \sum q_i \mathbf{v}_i/cr_i, \qquad (3)$$

so that $q\Phi$ and $(q\mathbf{v}/c).\mathbf{A}$ are the electric and magnetic energies in which charge q takes part.

As $d\mathbf{A}/dt = \partial\mathbf{A}/\partial t + (\mathbf{v}.\mathrm{grad})\mathbf{A}$, we can reduce eq. (2) to its usual form (known as the Lorentz equation)

$$d\mathbf{p}_0/dt = - q(\mathrm{grad}\Phi + \partial\mathbf{A}/c\partial t) + (q\mathbf{v}/c)\times\mathrm{rot}\mathbf{A}. \qquad (4)$$

The above formulas are written in a reference frame attached to absolute space (the space in which light velocity is isotropic) and I call (2) and (4) the absolute Newton-Lorentz equation.

Now I shall show which will be the form of the relative Newton-Lorentz equation, i.e., when working in a frame moving with a velocity $\mathbf{V}$ in absolute space. As I demonstrated with my "rotating axle" experiments[1-5], the Earth moves in absolute space with a velocity of about 350 km/sec and during a year this velocity suffers changes of about ± 30 km/sec because of the Earth's revolution about the Sun.

Thus let us suppose that the velocities of the test charge and the charges of the surrounding system in the laboratory are respectively $\mathbf{v}'$ and $\mathbf{v}_i'$. I shall obtain the relative Newton-Lorentz equation within an accuracy of first order in V/c, so that the Galilei formulas for velocity addition $\mathbf{v} = \mathbf{v}' + \mathbf{V}$, $\mathbf{v}_i = \mathbf{v}_i' + \mathbf{V}$ can be used. If working with a higher accuracy, the Marinov formulas for velocity addition[1,2,6] are to be used. Taking into account the Galilei formulas, we shall have

$$\Phi - \frac{\mathbf{v}.\mathbf{A}}{c} = \sum\frac{q_i}{r_i} - \frac{\mathbf{v}'+\mathbf{V}}{c}.\sum\frac{q_i(\mathbf{v}_i'+\mathbf{V})}{cr_i} \cong \Phi'\left(1 - \frac{\mathbf{v}'.\mathbf{V}}{c^2}\right) - \frac{\mathbf{v}'}{c}.\mathbf{A}' - \frac{\mathbf{V}}{c}.\mathbf{A}', \qquad (5)$$

where $\Phi' = \Phi$ is the relative electric potential which is equal to the absolute electric potential, as the electric potential is not velocity dependent, $\mathbf{A}' = \sum q_i\mathbf{v}_i/cr_i$ is the relative magnetic potential, and the expression on the right side is written within an accuracy of first order in V/c.

I beg the reader to take into account two substantially different invariances[1,2]: the Lorentz invariance and the Marinov invariance. One works with the Lorentz invariance when an observer considers the motion of a particle which first moves with a velocity $\mathbf{v}$ in absolute space and then with another velocity $\mathbf{v}'$, while one works with the Marinov invariance when the motion of a particle moving always with the same velocity $\mathbf{v}$ is considered by an observer who first is at rest in absolute space and then moves with a velocity $\mathbf{V}$. Thus the Lorentz invariance is to be applied when the observed particle changes its character of motion with respect to distant matter, while the Marinov invariance is to be applied when the observer changes his character of motion with respect to distant matter. For the Lorentz invariance there is a change in the momentum and energy of the observed particle and it involves 4-dimensional invariants, while for the Marinov invariance there is no change in the momentum and energy of the observed particle and it involves 3-dimensional invariants. For the theory of relativity it is of no significance whether the observed particle or the observer changes its (his) character of motion, however, unfortunately, these two cases are physically substantially different[1-10].

The "total" time derivatives of the absolute and relative magnetic potentials must be equal, i.e., $dA/dt = d\mathbf{A}'/dt$, because dA/dt depends only on the changes of the relative velocities of the charges of the system with respect to the test charge and on the distances and the changes of the distances between the former and the latter which are also "relative". Thus putting the above equality and (5) into (2), we obtain

$$\frac{d}{dt}\frac{m(\mathbf{v}+\mathbf{V})}{\{1-(\mathbf{v}+\mathbf{V})^2/c^2\}^{1/2}} = -q(\mathrm{grad}\Phi + \frac{1}{c}\frac{\partial\mathbf{A}}{\partial t}) + \frac{q}{c}\mathbf{v}\times\mathrm{rot}\mathbf{A} + \frac{q\mathbf{v}.\mathbf{V}}{c^2}\mathrm{grad}\Phi + \frac{q}{c}\mathbf{V}\times\mathrm{rot}\mathbf{A} + \frac{q}{c}(\mathbf{V}.\mathrm{grad})\mathbf{A}, \quad (6)$$

where the space and time derivatives are taken with respect to the laboratory, as we work only within an accuracy of first order in V/c[1,2,6], and, for brevity, we write all laboratory quantities in the last equation (and further in this paper) without primes.

Comparing formulas (6) and (4), we see that the "potential" (right) parts of these equations differ with the last three terms in eq. (6). As the electric (i.e., related to Φ) absolute effects are proportional to v/c, they are small, if $v \ll V$, with respect to the magnetic (i.e., related to $\mathbf{A}$) absolute effects which are not only comparable with the relative magnetic effects but, for $V > v$, are even bigger.

3. THE ROTATIONAL AND INERTIAL VARIATIONS OF THE DIRECT AND INVERSE ROWLAND EXPERIMENTS

Rowland[11] carried out in 1876 the following experiment: A disk was charged by positive (or negative) electricity. There was a magnetic needle in the neighbourhood of the disk. When the disk was set in rotation, the needle experienced a torque due to the magnetic action produced by the convection current of the charges rotating with the disk. I call this the direct Rowland experiment.

According to the principle of relativity, if the disk will be kept at rest and the needle will be set in rotation, the same torque has to appear. Such an experiment I call the inverse Rowland experiment. However, as I shall show beneath, according to the relative Newton-Lorentz equation (6), the magnetic needle will not experience a torque at the inverse Rowland experiment. As far as I know, nobody has carried out the inverse Rowland experiment to see whether there will be or will be no torque.

The above two experiments can be called rotational Rowland experiments. It is easy to transform them into inertial experiments. So if we charge a conveyer belt and set it in action, the motion of the charges can be considered as inertial (i.e., with a velocity constant in value and direction) over a considerable length of the belt and we shall realize thus the inertial direct Rowland experiment. On the other hand, if we move the magnetic needle with a constant velocity along the belt at rest, this will be the inertial inverse

Rowland experiment. As far as I know nobody has carried out the inertial direct and inverse Rowland experiments.

4. THE INVERSE ROWLAND EXPERIMENTS DO NOT DEMONSTRATE EFFECTS

Now I shall show that, contrary to the prediction of the principle of relativity, the inverse Rowland experiments must be null, i.e., a magnet moving with respect to charges at rest does not experience torque.

Thus, proceeding from the relative Newton-Lorentz equation (6), I shall show that when there is an infinitely long (or very long) belt covered with electric charges and a magnet in its neighbourhood (let us consider a solenoid feeded by constant current), then, in the case that the belt will be moved with the relative velocity **v** in the laboratory, there will be a torque acting on the magnet at rest, however, in the case that the belt will be at rest and the magnet will be moved with the same velocity **v**, there will be no torque.

Let us suppose that the absolute velocity of the laboratory is **V** and let us consider some electric charge q moving with the laboratory velocity $\mathbf{v}_m$ in some wire element of the magnet (as I showed[5] v_m is of the order of c). Denoting by Φ and **A** the laboratory electric and magnetic potentials generated by the electric charges fixed to the belt at the point of location of the charge q, and taking into account that the current charges q are in excess with respect to the positive ions of the metal lattice, we shall have for the potential forces acting on this charge q, according to eq. (6), for the case when belt and magnet are at rest in the laboratory

$$\mathbf{F} = - q\,\mathrm{grad}\Phi + q(\mathbf{v}_m.\mathbf{V}/c^2)\mathrm{grad}\Phi. \tag{7}$$

As $v_m \cong c$ and $qv_m = Idr\mathbf{n}$, where I is the current in the coil, dr is its wire element and **n** is the unit vector along this wire element in the direction of the current, we shall have

$$\mathbf{F} = - (Idr/c)\mathrm{grad}\Phi(1 - \mathbf{n}.\mathbf{V}/c) \cong - (Idr/c)\mathrm{grad}\Phi. \tag{8}$$

It can be shown that this force is small with respect to the force of attraction due to the electrostatic induction of the charges on the belt and the metal wire of the coil.

For the case when the magnet will be moved with the relative velocity **v** in the laboratory, the acting force will be

$$\mathbf{F}' = - q\,\mathrm{grad}\Phi + q\{(\mathbf{v}_m + \mathbf{v}).\mathbf{V}/c^2\}\mathrm{grad}\Phi = \mathbf{F} + q(\mathbf{v}.\mathbf{V}/c^2)\mathrm{grad}\Phi. \tag{9}$$

As $v \ll c$, the additionally acting force

$$\mathbf{F}' - \mathbf{F} = q(\mathbf{v}.\mathbf{V}/c^2)\mathrm{grad}\Phi \tag{10}$$

is extremely small with respect to the initial force **F** and surely there will be no experimental possibilities to register it, so that we can write

$$\mathbf{F}' \cong \mathbf{F}. \tag{11}$$

For the case when the belt will be moved with the velocity **v** in the laboratory, the force acting on the charge q of the magnet at rest will be, taking into account that now the laboratory magnetic potential of the charges on the belt will be $\mathbf{A} = \Phi\mathbf{v}/c$ and using in the last two terms of (12) the formulas for rotation and vector-gradient of double products[2],

$$\mathbf{F}'' = -q\,\mathrm{grad}\Phi + q(\mathbf{v}_m.\mathbf{V}/c^2)\mathrm{grad}\Phi + (q/c)\mathbf{v}_m\times\mathrm{rot}\mathbf{A} + (q/c)\mathbf{V}\times\mathrm{rot}\mathbf{A} + (q/c)(\mathbf{V}.\mathrm{grad})\mathbf{A} =$$

$$-q\,\mathrm{grad}\Phi + q(\mathbf{v}_m.\mathbf{V}/c^2)\mathrm{grad}\Phi + (q/c)\mathbf{v}_m\times\mathrm{rot}\mathbf{A} + q(\mathbf{v}.\mathbf{V}/c^2)\mathrm{grad}\Phi =$$

$$\mathbf{F} + (q/c)\mathbf{v}_m\times\mathrm{rot}\mathbf{A} + q(\mathbf{v}.\mathbf{V}/c^2)\mathrm{grad}\Phi. \quad (12)$$

Now, taking into account that $v \ll c$, we shall obtain for the additionally acting force

$$\mathbf{F}'' - \mathbf{F} \cong (q/c)\mathbf{v}_m\times\mathrm{rot}\mathbf{A} = I\,dr\,\mathbf{n}\times\mathbf{B}/c, \quad (13)$$

where **B** is the magnetic intensity generated by the charges moving with the belt. This force is considerable and there will be a torque acting on the magnet.

5. THE EXPERIMENT SUPPORTS THE ABSOLUTE CONCEPTS

I carried out the rotational direct and inverse Rowland experiments. A rim of a plastic disk was covered with a brass ring. This metal ring, cut over a small distance, was connected by a wire with the axle of rotation and this axle was connected by the help of sliding contact with one pole of a Wimshurst machine which produced tension between both poles U = 80 kV, and I assumed that the potential to which the disk was charged was $\Phi = U/2 = 40$ kV. For a detector of the magnetic field I took not a magnetic needle, as was the case in the historic Rowland experiment and in all its repetitions, but a small Hall detector whose output was led to an amplifier ending with a trigger. When the trigger was overturned, it illuminated a lamp. The trigger could be tuned so that at an increase of the magnetic intensity over the Hall detector of few micro Gauss the lamp was illuminated. The capacitance of the disk with radius R = 20 cm was of the order of $C = 10^{-11}$ F. If charged to a potential Φ, the charge over the disk will be $Q = C\Phi$. At N rotations in a second this charge will produce current $I = QN$. This convection current, from its side, will produce at a distance ρ ($\rho > R$) from the center of the disk the following magnetic intensity (see Ref. 7, p. 307) - the formula is in the SI system of units -

$$B = \frac{\mu_0 I R^2}{4(\rho^2 - R^2)^{3/2}} \cong \frac{\mu_0 I R^2}{4\{2R(\rho - R)\}^{3/2}} = \frac{\mu_0 C\Phi N R^{1/2}}{4\{2(\rho - R)\}^{3/2}}. \quad (12)$$

Putting here $\mu_0 = 4\pi 10^{-7}$, $C = 10^{-11}$ F, $\Phi = 4\times10^4$ V, N = 1 rev/sec, R = 0.2 m, $\rho - R = 0.004$ m, we obtain $B = (\pi/4)10^{-10}$ T/rev $\cong$ 1 μG/rev.

When rotating the charged disk, the lamp became illuminated at some N = 10 rev/sec. However when the disk was kept at rest and the Hall detector together with its battery, the amplifier, the trigger and the lamp was rotated about the disk, there was no light even for N = 20 rev/sec.

The plane of the Hall detector lied in the plane of the disk. When rotating the Hall detector, its plane must remain exactly parallel to the plane of rotation. If the Hall detector will make a small angle with the plane of rotation, the lamp was illuminated and extinguished even when the disk was not charged, because of the change of the Earth's magnetic intensity over the Hall detector. This effect served as an indication of the sensitivity of the Hall detector. As the Earth's magnetic intensity is $B_E = 0.5$ G, then if the angle between B_E and the plane of the Hall detector is θ, the component of the Earth's magnetic intensity perpendicularly to the plane of the detector will be $B_{E\perp} = B_E \sin\theta \cong B_E\theta$. Thus, for $\theta = 1^o \cong 1/57$ rad, we shall have $B_{E\perp} \cong 10\ \mu$G Earth's magnetic intensity over the Hall detector.

It is obvious that there are no technical problems for realizing also the inertial direct and inverse Rowland experiments.

These childishly simple experiments show that the electromagnetic effects depend on the absolute velocities of the charged bodies and that the principle of relativity is wrong.

6. CONCLUSIONS

Thus the direct and inverse Rowland experiments carried out by me showed that the effects observed are not the same. Contrary to the prediction of my absolute space-time theory and contrary to the experimental results, the theory of relativity predicts the follwoing nonsense[13]:

> A stationary magnetic dipole (e.g., a compass needle) in general experiences a torque in the presence of a moving charge, since the latter creates a **B** field; transferring our observations once more to the inertial rest frame of the charge, we conclude that a magnetic dipole moving through a static electric field must experience a torque.

REFERENCES

1. S. Marinov, Eppur si muove (C.B.D.S., Bruxelles, 1977, third ed. East-West, Graz, 1987).
2. S. Marinov, Classical Physics (East-West, Graz, 1981).
3. S. Marinov, Czech. J. Phys. **B24**, 965 (1974).
4. S. Marinov, Gen. Rel. Grav. **12**, 57 (1980).
5. S. Marinov, The Thorny Way of Truth, Part II (East-West, Graz, 1986).
6. S. Marinov, Found. Phys. **9**, 445 (1979).
7. S. Marinov, TheThorny Way of Truth, Part I (East-West, Graz, 1988).
8. S. Marinov, The Thorny Way of Truth, Part III (East-West, Graz, 1988).
9. S. Marinov, Nature **322**, p. x (21 August 1986).
10. S. Marinov, New Scientist **112**, 48 (1986).
11. H. A. Rowland, Sitzungsber. d. k. Akad. der Wissensch. zu Berlin, p. 211 (1876).
12. S. Marinov, The Thorny Way of Truth, Part VII (East-West, Graz, 1990).
13. W. Rindler, Am. J. Phys. **57**, 993 (1989).

ONCE MORE ON SILVERTOOTH'S EXPERIMENT FOR MEASUREMENT OF THE AETHER DRIFT

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Abstract. Silvertooth has asserted in the past that he has succeeded in measuring the Earth's absolute velocity by measuring the different spacing between the nodes of a standing wave at its different orientations with respect to the laboratory's absolute velocity. I showed that this method is inconclusive. Now Silvertooth asserts that he has succeeded to measure the Earth's absolute velocity by measuring the different phases in the illuminations at the antinodes of the standing wave. This method is theoretically conclusive but, because of the quick change in the illuminations, I do not see, at the present state of experimental technique, possibilities for detecting the effect. However if standing waves in wave guides should be used a positive effect might be detected.

Silvertooth has announced in a preliminary information(1) and in a pretty enigmatically written paper(2) that he has succeeded to measure the Earth's absolute velocity by an optical experiment without making a Newtonian time synchronization, i.e., without using a rotating axle (as was the case in all laboratory measurements of the Earth's absolute velocity up to now(3-5)).

The gist of Silvertooth's experiment was the assertion that if two oppositely propagating light beams interfere, then the distance between the nodes of the produced standing wave will depend on the angle which the standing wave concludes with the laboratory's absolute velocity. However, if a light beam interferes with its own reflection by a mirror, the distance between the nodes will not depend on the mentioned angle.

So in Ref. 1 Silvertooth writes:

> The experiment shows that the spacing between nodes in the standing wave set up by the oppositely-directed light rays from the same laser source is a function of the orientation of the apparatus... In effect, it appears that in the standing-wave conditions, the waves move at different speeds in opposite directions relative to the apparatus and, as their frequencies are the same, they present different wavelengths in the two directions and so affect the nodal spacing.

Silvertooth detects the positions of the nodes by a specially constructed transparent detector(6) with thickness of the photosensitive layer much smaller than the length of the standing wave. The positions of the nodes of a standing wave interfering with its own reflection are detected by the detector of a Michelson inteferometer. In Ref. 2 Silvertooth writes:

> If the translating member (i.e., the two solidly attached one to another mirrors reflecting two split light beams coming from a laser in two opposite directions - S.M.) moves an amount λ (in parallel to the absolute velocity of the laboratory - S.M.), then the wave impinging on D_1 (the transparent detector - S.M.) from the one side will advance less than a wave ($\lambda_1 > \lambda$), and the wave impinging on D_1 from the other side will retard more than a wave ($\lambda > \lambda_2$). Thus the two waves will remain in the same relative phase, but the standing wave pattern will have shifted with respect to the photocathode of the detector D_1 by a first-order amount $\delta = \lambda v/c$.

Before having read Ref. 2, I heard about Silvertooth's experiment from a private source. Accepting Silvertooth's thesis, I repeated his experiment in a very easy variation (which can be mounted in a day in any optical laboratory) where Silvertooth's transparent detector was exchanged by a non-transparent one. I called Silvertooth's experiment the quasi-Wiener experiment, while to my variation I gave the name the quasi-Michelson experiment. I carried out the experiment on the 2, 3 and 4 January 1987 and I registered a definite positive effect. However, later I understood that the positive effect observed by me was due only to the non-parallelism of the split light beams, so that by moving the mirrors reflecting these beams the changes of the light paths in the two interferometers resulted to be different and both detectors showed non-synchronously appearing anti-nodes. Thus I concluded that, as my theory also predicted[7], Silvertooth's experiment cannot give a positive effect and published my theoretical arguments and description of my experimental arrangement[8].

Now[9] Silvertooth published a new description of his experiment where the thesis that the nodal spacing scanned by the transparent detector depends on the orientation of the apparatus is no more defended. According to Ref. 9, the nodal spacings scanned by the "Wiener" and "Michelson" detectors remain equal but there is only a shift in the "phases" of the illuminations at the antinodes scanned by both detectors. This effect is existing and I have calculated it in Ref. 7 and 8. So in Ref. 7, p. 162, and in Ref. 8, p. 189, I wrote:

Hence the distances between the nodes of the standing wave when the Wiener experiment is performed in a frame at rest and in motion with respect to absolute space will be exactly the same, and not even second-order differences in the pattern can be observed. The only difference is the following. When the laboratory is at rest in absolute space (or its velocity is perpendicular to the direction of light propagation), E (the electric intensity, although it is to be noted that one measures always E^2) takes its maximum at all antinodes (i.e., for $x = n\pi/k$, where n is an integer and k is the angular wavenumber) at the same moment, and when the velocity of the laboratory is parallel to the direction of light propagation, E takes its maximum at the different antinodes at different moments. For a given moment t, the electric intensity obtains its maximum at the antinodes with coordinates near to $x = \{(2n+1)\pi/2\omega - t\}(c^2/v)$, while for this moment t it is zero at the antinodes with coordinates near to $(n\pi/\omega - t)(c^2/v)$, where ω is the angular frequency. This is the only effect which is offered by the quasi-Wiener experiment and I am sceptical about a possibility for its experimental verification.

Now Silvertooth asserts that he has measured exactly this effect. Indeed the difference between the antinode where at a given moment the illumination is maximum and the next antinode where at this very moment it is null is

$$\Delta = x_{max} - x_0 = \{(2n+1)/4\nu - t)\}(c^2/v) - (n/2\nu - t)(c^2/v) = c^2/4\nu v = \lambda c/4v. \quad (1)$$

However, according to Silvertooth for different lengths of the one interfering beam in the Michelson interferometer the light intensities at its antinodes will achieve their maxima always "at the same moment".

Thus if at a certain initial situation Silvertooth's detector and Michelson's detector are at an antinode and the light intensities there achieve maxima at the same moment, then if displacing the Silvertooth detector over a distance $\Delta = \lambda c/4v$ at a new antinode, the maximum intensity will be achieved for this moment when the light intensity at the Michelson detector will be zero. Silvertooth moves together his detector and one of the mirrors in Michelson's interferometer, but the second shift is absolutely not necessary. It is enough to shift only the Silvertooth detector, so that the "phases" of illuminations change with 90^0.

Well, I agree that in this way a positive effect can be observed. However, let us take into account that the time in which the illumination at an antinode goes from maximum to zero is $T/4 = 1/\nu$, i.e., it is equal to 1/4th part of the period of the light wave T. For He-Ne light $T = \lambda/c \cong 2.10^{-15}$ sec. I do not know at the present time an experimental method for detecting the sinusoidal character of such quick illumination change. If Silvertooth has succeeded in doing this, his experimental achievement is of an enormous importance for all opticians. Thus if Silvertooth was successful, he has brought down to the Earth two stars: he has measured for a first time the Earth's absolute velocity without using a rotating axle for realizing a Newtonian time synchronization and for a first time he has observed the sinusoidal change of light illumination at the antinode of a standing wave. I however doubt that he was successful.

Nevertheless his method seems very interesting if, instead of light, radio waves should be used. Indeed let us imagine two wave guides closed at the one end and feeded at the other end by two generators emitting short waves with the same frequency. The guides are in parallel one to another and in parallel to the laboratory's absolute velocity, and standing waves are produced along them. An energy detector can be shifted along the one guide which remains solid in the laboratory and a second energy detector is put in the second guide remaining fixed to the latter. The outputs of the detectors are led to a double beam oscilloscope. Let at the initial moment the sinusoidal signals coming from both detectors are "in phase". If now we shift the one detector, the oscillosope and the second waveguide with its detector over a distance $\Delta = \lambda c/4v$, the "phase difference" between the signals will become 90^0. Taking $\lambda = 1$ cm, $v = 300$ km/sec, we obtain $\Delta = 2.5$ m.

REFERENCES

1. E. W. Silvertooth, Nature **322**, 590 (1986).
2. E. W. Silvertooth, Spec. in Sc. and Techn. **10**, 3 (1987).
3. S. Marinov, Czech. J. Phys. **B24**, 965 (1974).
4. S. Marinov, Gen. Rel. Grav. **12**, 57 (1980).
5. S. Marinov, The Thorny Way of Truth, Part II (East-West, Graz, 1986).
6. E. W. Silvertooth, Appl. Optics **22**, 1274 (1983).
7. S. Marinov, Eppur si muove (Centre Belge de Document. Scient., Bruxelles, 1977).
8. S. Marinov, Spec. in Sc. and Techn. **12**, 187 (1989).
9. E. W. Silvertooth, Electr. and Wireless World p. 437, May 1989.

ОКНО В ЕВРОПУ

Великий царь рубить окно решил в Европу из России. -
И прорубил, хотя его не делать этого просили.

Но смертен царь. И время вспять пошло: энтузиасты с пылом
окно заделали опять - и снова стало все как было.

Прошло сто лет. Пришел в Париж Петра пра-правнук с бравой песней.
И снова рубит он окно - туда же, но на новом месте.

Ура! Сквозь строй фельдегерей в окно в Европу наши ходят
за неимением дверей. И толчеи не производят.

Вдруг царь помре. И леший с ним! Уж все царю другому вторят.
Окно знаменьем осеним и досками забьем вдругорядь.

Года идут. Цари царей сменяют в нашем бодром срубе.
То мы без окон, без дверей - то снова дружно стены рубим.

До полюсов летят опилки, и топоры дубасят с толком:
то там окно заколотят, то здесь в стене прорежут щелку.

И все при деле. Есть черта, жить за которой нам не стыдно:
окон в Европу до черта. Европы лишь из них не видно...

Не перейти нам Рубикон, пред коим вздыблен всадник медный.
Процесс рубления окон незавершим. Он перманентный.

ВАНЯ, русский бард на пути в Израиль
заезжающий через венское окно в
Коннектикэт, когда брешь в
берлинской стене трудно было
видеть даже во сне.

- Плохо у тебя идут дела с перестройкой, Миша, говорит Сталин.

- Знаю, знаю, Йос Виссарионович. А что мне делать?

- Ва-пэрвих, расстреляй все политбюро. Ва-втарих, перекрась Савеловский вокзал в сиреневый цвет.

- А зачем в сиреневый?

- Маладэц, Миша. Я знал, что ты мне этат ва-апрос задашь.

Разночтение: - Харашо, Миша, я так и знал, что по второму
пункту у тэбя будут вопросы.

- Под каким именем войдет Эскамилье Сергеевич в историю?

- Под именем СЕКРЕЦАРЬ-ОСВОБОДИТЕЛЬ.

C O N T E N T S :

Crean 4/30/01

Eqn. (4) p. 29, third expression, is it correct algebra

Eqn. (7) p 31, Whitehead expt. was null. How does this relate to Graham-Lahoz expt.?

The seventh part of the collection of documents THE THORNY WAY OF TRUTH (TWT) is dedicated quite the whole to Maxwell's displacement current which, according to conventional physics, must have all magnetic properties of conduction currents. Marinov has shown that this concept is wrong. His original experiment demonstrating that displacement current does not act with potential forces on other currents was presented in TWT I. In TWT VII is presented Marinov's repetition of the historic Whitehead's experiment, put by the Maxwellians-Machiavellians under the rug, which demonstrates that displacement current does not react with kinetic forces to the action of other currents. Marinov is photographed above with his CHILDISHLY SIMPLE experiment which consists of a cylindrical condenser put in the orifice of a big coil. Between the condenser's plates either a metal ring or a ring of dielectric can easily rotate. The capacitances in both cases are made equal. Thus in both cases, by applying the same tension, the same current flows, and the torque acting on the conduction current in the metal ring brings it to continous rotation. According to the Maxwellians, the same torque must also act on the ring of dielectric, while the experiment shows NO TORQUE. Thus the interaction between circuits interrupted by condensers is an interaction between NON-CLOSED loops and, because of Grassmann's formula, may violate Newton's third law, as Marinov has already demonstrated with his Bul-Cub machine without stator (TWT III) and with his RABDC-machine (TWT IV). However the knights-editors mounting the world's physical journals, under the command of the hardy Sir John frome NATURE, raise their shields against Marinov's papers in a desperate effort to save pitiable scientific lies.

Price: $ 25