THE Industrial Research Institute, which is affiliated with the National Research Council, will meet in Detroit on September 26 and 27. The Hotel Statler has been designated as headquarters.

DISCUSSION

THE MAGNETIC CURRENT

NOT only electric currents but also magnetic currents flow through the universe.

I reached this conclusion by consecutive and persistent observation of single submicroscopic particles suspended in gases.[1] Using this method in my small condenser I can measure forces of an order of magnitude down to 10^{-10} dynes. Therefore my measurement of forces is more sensitive by the factor of 10^4 than any direct measurements of forces made so far. I was able to find new facts because methods of the highest possible sensitivity were used.

These observations can be summed up in two sentences:

(1) *Particles of matter, irradiated by a concentrated beam of light, move in a homogeneous electric as well as magnetic field in or against the lines of force.* (Electro-photophoresis, magneto-photophoresis). I have therefore concluded that these particles are charged under the impact of light. There exist not only electric but also magnetic charges.

(2) *Particles of the same kind and size move simultaneously toward and against the propagation of the light.* I called the movement away from the light lightpositive and that toward the light lightnegative longitudinal photophoresis.[2] I have therefore concluded that the light beam has potential differences along its propagation which cause the particles on which charges are induced to move in or against the direction of propagation. To the well-known oscillating fields in the beam of light have to be added these stationary electric and magnetic fields.

Before such fundamental conclusions can be drawn one must first see if there is no other explanation possible in accord with existing theories. Working for decades on the experiments and their interpretation I was forced to believe that only such an electromagnetic interpretation can be in accordance with all observable facts.

Heat or mechanical effects—so-called radiometer forces (Crookes)—can not account for these phenomena for the following reasons: There is a photophoretic force in liquids which is of the same order of magnitude as in gases, although no radiometer forces exist in liquids. Silver or copper particles in gases which are reflecting strongly exhibit a tremendous lightnegative movement, though they ought to be most heated on the side toward the light, and one would expect a movement away from the light. It seems impossible to explain the reversibility of the particles with corresponding reversals of the field. The energy of the fields alone is responsible for the orientation of the particles and is a quadratic function of the potentials. One therefore should not expect a change of direction in the motion of uncharged particles if the field is reversed. Were the movement due to heating effects, one could not explain why the particles move across and along the inner part of the beam instead of going entirely out of it. It would also seem strange that the movement of nickel particles under the influence of the geomagnetic field, as it was observed in my institute in Vienna (Austria), could be compensated by a superposed magnetic field of about 0.4 gauss. Furthermore, the movement of the particles always follows the lines of force, no matter from which direction the light may come. This would be impossible if the movement were due to heating effects. That some particles start to move suddenly from rest, that the photophoretic movement suddenly disappears and sometimes increases or decreases gradually, and many other observations can not be explained by mechanical or heat effects.

When I came to the conclusion that there are single magnetic poles (magnetic charges), it was therefore not necessary to ask if this agreed with existing theories, but rather whether there are any experimental facts that contradict it. It can be stated here that so far there are no experimental facts which contradict this conclusion of the existence of single magnetic poles. A study of the literature made with Leo Banet showed the following situation:

It has been the predominating opinion up to the present time that a real quantity of positive or negative electricity can be enclosed within an arbitrarily chosen geometric surface. But no matter how the surface is chosen it will always enclose the same amount of south and north magnetism. In other words, there are true quantities of electricity of either

[1] F. Ehrenhaft, *Annalen der Physik*, 56: 81, 1918; *Philos. Mag.*, 11: 141, 1931; *Annales de Physique*, (Paris) 13: 151, 1940; *Phys. Rev.*, 57: 562 and 659, 1940; *Jour. Franklin Inst.*, 230, 381, 1940; *Nature*, 147: 25, January 4, 1941; F. Ehrenhaft and L. Banet, *Nature*, 147: 297, March 8, 1941; F. Ehrenhaft, *Philosophy of Science*, 8, No. 3, 1941, "The Microcoulomb Experiment" (charges smaller than the electronic charge), see p. 36; F. Ehrenhaft and Leo Banet, *Philosophy of Science*, 8, No. 3, 1941. The older references about photophoresis are given in *Annales de Physique*, 13: 151, 1940.

[2] I have recently constructed the apparatus on which the above-mentioned phenomena can be seen at C. Zeiss Inc., New York. The latest descriptions of the apparatus and of the experiments are given in *Annales de Physique*, 13: 151, 1940.

sign, but no true magnetic ones. This statement has been made quite clearly by James Clerk Maxwell in his "Treatise on Electricity and Magnetism." Maxwell tried to prove that there was no such thing as true magnetism. May I remind you here that *in principio* it is impossible to prove from experiments that something is non-existent. Furthermore, the two experiments which Maxwell quotes are not conclusive. The first one states that a broken magnet gives two entire magnets with equal poles. If a non-magnetic piece of iron is broken, it can be observed that the fragments become magnetized in various ways on the broken ends. The effect is the same when a non-electrically charged glass or sulphur rod is broken, and shows at the ends various kinds of electric charges. This phenomenon is easily explained, since each breaking creates constriction. Each constriction, however, creates electricity and magnetism. The breaking experiment therefore, does not prove that true magnetism does not exist, as Maxwell stated.

The second experiment, which probably originated with the ancient Chinese and is quoted by P. Peregrinus (*anno* 1269), indicates that a magnet floating upon water directs itself but does not move. From this has been concluded that the amount of north and south magnetism is equal in each magnet. It is easy to perceive that the mobility of such a big floating magnet is much too small to show slight differences of charge. The particles on which my observations were made have a mobility a million times greater than that of the floating magnet of Peregrinus. Such particles irradiated with light move in a homogeneous magnetic field in the lines of force. Thus my sensitive experiment gives evidence of the existence of true magnetism. In other words, the Peregrini-Maxwell experiment turns out to be positive in my small condenser, when light is used.

My interpretation not only explains all observations in a rather simple manner, but also makes a number of new conclusions possible. One of these is that light magnetizes matter. Leo Banet and I succeeded in magnetizing small pieces of iron by means of irradiation with ultraviolet rays. Lilly Rona has expressed the idea that, concluding from these experiments, it should be possible to extract electricity from the beam of light originating from these stationary components. I believe that she is right, and that it could be done without the use of the photoelectric effect, that means without deteriorating and decomposing matter itself.

Under the influence of the light matter coagulates more readily because of the induced poles (charges). Sometimes the light separates amorphous and crystalline particles, and sometimes it makes crystals grow toward it (heliotropism of crystals).

Light causes irregularities in Brownian movement and therefore also in diffusion because of photophoresis.

Light causes ponderomotive forces to act upon matter apart from the effects of the light pressure. These ponderomotive forces are produced by the stationary components and induced charges. The latter have attracting or repelling effects.

I determined the magnitude of the charge of the magnetic ion and found it to be of the same order of magnitude as the electric one.

A new phenomenon which I called the trembling effect found a simple explanation, the frequent change of the magnetic charge occurring predominantly in weak magnetic fields in the beam of light.

Leo Banet has drawn important conclusions in regard to the effects on the sun and the earth that will be described in another paper.

Now I shall say a few words about the *magnetic current*. We have shown the existence of unipolar magnetic charges, which flow in a homogeneous magnetic field in or against the direction of the lines of force. This can be observed directly by means of a microscope. Therefore we have to deal with magnetic currents in a physical and technical sense. Around a magnetic current there exists an electric field. Furthermore a magnetic current produces heat in a medium conducting magnetism.

I have attempted to show that a beam of light causes or induces not only heat and electricity but magnetism at the same time.

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EFFECT OF THYMUS EXTRACT INJECTIONS ON RATS

FOLLOWING the report of Rowntree and coworkers[1] on the marked precocity of development and growth resulting from daily peritoneal injections of thymus extract to successive generations of rats, an attempt was made to repeat these findings. Correspondence with Drs. Rowntree and Hanson regarding the preparation of the extract greatly facilitated our work. No positive findings were obtained by us, even after carrying the rats to the F_4 generation. This was not reported at the time because we felt that perhaps the calves from which the thymus glands were obtained were not of the age specified.

With the publication of a modified method for the preparation of the extract by Steinberg,[2] the work was repeated, using this method of preparing the extract. This time we had a source of supply from which we could definitely obtain thymus glands from calves of the type stressed: local stock, milk-fed, two

[1] L. G. Rowntree, J. H. Clark and A. M. Hanson, *Am. Jour. Physiol.*, 109: 90, 1934.

[2] A. Steinberg, *Endocrinology*, 23: 581, 1938.