Felix EHRENHAFT

Magnetic Current

(1) Alden Armagnac: *Popular Science* (June 1944); "Magic With Magnetism"

(2) *Popular Science* (April 1945), p. 208: "Ehrenhaft Discovery Confirmed by New Experiments"

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(1) *Popular Science* (June 1944), pp. 130-134, 222

Magic With Magnetism

By Alden Armagnac

Prof. Felix Ehrenhaft displays a tube of gases produced, he says, by decomposing water with a magnet

If this experimenter is right, his discovery will upset all out accepted ideas on this familiar force

Can a magnet take water to pieces? No, say physics textbooks. Yes, says Prof. Felix Ehrenhaft, former director of the Physical Institute at the University of Vienna, who now carries on his research in New York. If he should turn out to be right, his findings in the realm of magnetism promise practical applications as far-reaching as the dynamos, motors, transformers, telephones, and radio that have stemmed from Faraday's research in electricity.

For his "impossible" experiment, Dr Ehrenhaft employs the simplest of apparatus. Two shiny rods of pure

Swedish iron, sealed in holes through opposite sides of a U-shaped tube, resemble a setup familiar to high-school students for breaking up water into hydrogen and oxygen gases by passing electricity through it. And that is exactly what would happen if Dr Ehrenhaft attached electric wires from a battery to the rods. But, he does no such thing.

Instead, he uses the iron rods as pole pieces, or North and South ends of a magnet --- either an electromagnet or a permanent magnet. Bubbles of gas rise through the twin columns of acidulated water, to be collected and analyzed. As might be expected, nearly all of the gas is hydrogen, liberated by a commonplace chemical interaction between the iron rods and sulfuric acid, one percent by volume, in the water. But the phenomenal part of the experiment is that oxygen also turns up, Dr Ehrenhaft recently told the American Physical Society. To be specific, it is found in clearly measurable proportions ranging from 2 to 12% of the total volume of gases. When the gases obtained with a permanent magnet are separated, the larger proportion of oxygen is found above the north pole of the magnet. After rigorous precautions that seem to rule out all other explanations --- including short-circuiting the magnet poles with wire, so that the poles will be at the same electric potential --- Dr Ehrenhaft concludes that there is only one place the oxygen can come from. And that is from the water decomposed with a magnet! Without a magnet, pure hydrogen is evolved.

There is an interesting sidelight to this experiment. A strong permanent magnet of the Alnico type suffers a marked loss of strength --- say, 10% in 24 hours --- after being used to decompose water, Dr Ehrenhaft observes. In fact, makers of the magnets, which are supposed to last for years without material change, have viewed what happens to them with astonishment and dismay. But no fault lies with their products. Energy from an electric battery is used up in decomposing water, and it would be only reasonable to expect energy stored in up in a permanent magnet to be drained likewise.

What gives the utmost significance to the reported feat of breaking up water with a magnet is the fresh evidence it offers for the existence of "magnetic current", or a flow of magnetically charged particles, which has been suspected by noted pioneers and which Dr Ehrenhaft now maintains he has proved. Confirmation of this amazing discovery would point to a possible future rival of electric current, perhaps capable of being harnesses in undreamed-of ways.

Needless to say, the scientific world will require a whole lot of convincing, since Dr Ehrenhaft's conclusions flatly contradict long-established beliefs. As every schoolboy is taught, a magnet has a north pole and a south pole. Break it in two with a hammer, and each piece will have a north pole and south pole of its own. No law forbids you to imagine a magnet with only one pole, and the idea comes in handy in certain electrical and radio calculations. But as for actual fact, you cannot have one pole without the other, an experimenter named Peter Peregrinus believed; he demonstrated it to his satisfaction, using a lodestone, in the year 1269, and prevailing opinion has backed him up ever since. As we kiow now, the lodestone that he floated on a platform in water simply turned until its north pole faced the south magnetic pole of the earth, and vice versa. It showed no observable excess of north or of south magnetism --- and hence the conclusion that the two are always equal.

But would the dictum of no separate magnetic poles still hold true in a far more delicate test --- say, if you substituted microscopic particles of iron or other magnetic metals, as tiny as particles of smoke, for the massive chunk of rock that Peregrinus used? Dr Ehrenhaft has tried it. In an air gap between the north and south poles of a magnet, he sets up what he calls a homogenous magnetic field, that is, with the lines of force absolutely parallel. In this field, he finds, the meal particles move toward the north or south pole, reversing their direction according to the direction of the magnetic field. In the particles, he concludes, there must be an excess of N or S magnetic charge. Expanding the terminology of Faraday, he calls the particles magnetic ions. They are the single magnetic poles shown at the lower right of the drawing. Instead of bearing plus or minus electric charges, as familiar ions do, they carry N or S magnetic charges.

Now, just as traveling electric ions form an electric current, why shouldn't traveling magnetic ions form a magnetic current? See for yourself another of Dr Ehrenhaft's startling experiments, and draw your own conclusions.

This time the heart of the apparatus will be a small glass cell, fitted as before with pole pieces of pure iron that dip into water containing one percent of sulfuric acid. An electromagnet, turned on or off at will, energizes the poles. From a projector, a powerful beam of light converges upon the narrow gap between the pole pieces, and a low-power microscope, mounted horizontally, reveals that happens there. Adding a camera provides a permanent record.

You begin with the magnet turned off. Looking into the eyepiece of the microscope, you see streams of bubbles rising from both pole pieces. They are of hydrogen gas, liberated by the same chemical action as the first experiment.

Throw the switch that turns on the magnet, and the scene abruptly changes. Stopped dead in their tracks, some of the bubbles cling to the pole pieces. Others leave one pole and travel to the other. Dr Ehrenhaft calls special attention to bubbles moving downward against their own buoyancy, impelled by some unseen force stronger than gravity.

Meanwhile a spectacular phenomenon has been developing --- a miniature merry-go-round of gas bubbles between the faces of the poles and parallel to them. Incapable of being shown adequately in a time exposure, the effect nevertheless appears plainly as a white blur, when the upper magnetic pole is given a conical shape for photographic purposes. Visual observation shows striking details. If copper particles, say, have been added to the acidulated water, they will rotate in the same plane as the hydrogen bubbles, but in the opposite direction. For both, the speed of the whirligig depends upon the strength of the magnetic field. Reverse the polarity of the magnet, and each set of particles spins in the opposite direction.

Here are no wild-eyed theories, but perfectly demonstrable facts. Any skeptical physicist has a standing invitation to see them with his own eyes at Dr Ehrenhaft's laboratory, placed at his disposal in the New York City quarters of the famous Carl Zeiss optical firm. How to account for the phenomena remains a challenge to science, unless Dr Ehrenhaft's conclusions are to be accepted. See how neatly they would draw an analogy between well-known electric effects and the new-found magnetic effects:

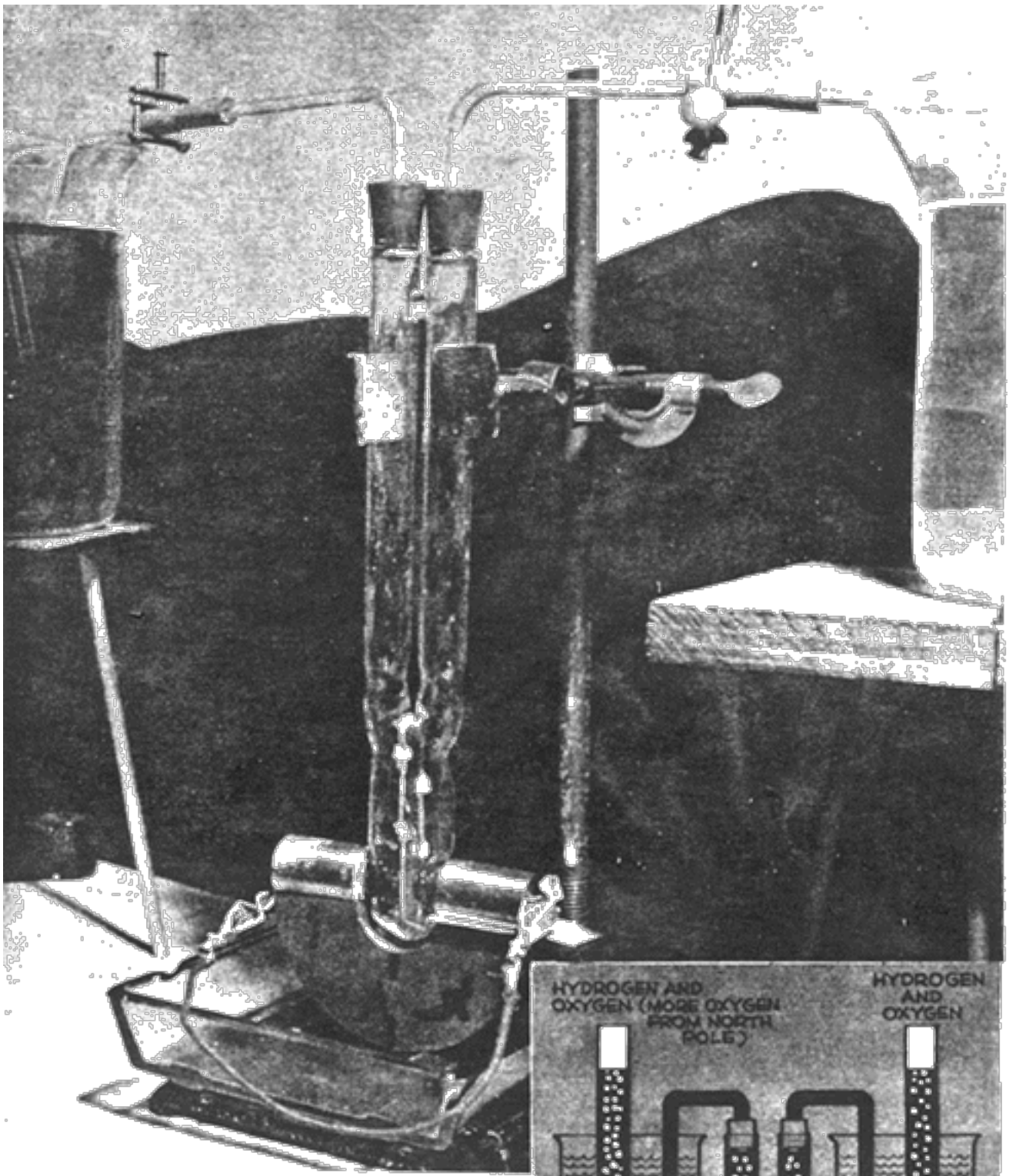
Bubbles or particles that travel between pole pieces of a magnet behave just as if they were magnetic ions, or clusters of thyem --- repelled by like magnetic poles, and attracted by oppositely magnetized poles. This corresponds exactly with the way that "electric"or ordinary ions interact with positive and negative electrodes. And as for the ring-around-the-rosy behavior of the hydrogen bubbles and copper particles, Dr Ehrenhaft concludes that these are electrically charged particles --- ordinary ions--- rotating about a magnetic current. This would be an exact counterpart of the classical conception that magnetism rotates about a current-carrying electric conductor.

Now the staggering implications of Dr Ehrenhaft's observations begin to unfold. Existence of such a thing as magnetic current, once established, would pave the way for inductries as gigantic as those that the discovery of electricity led to in its time. A "gold rush" for practical applications might be expected. Patents for them would command fabulous sums, since inventions employing magnetic current would be basic.

What form they may take, no man can foresee, and Dr Ehrenhaft cautiouslydeclaines to hazard a guess. Yet a visitor to his laboratory cannot resist the temptation to let his imagination run free. New kinds of motors and generators? Better ways to transmit power? Transformers that will work on direct current isntead of alternating current? Atom smashers? Radical methods of seeing things in the dark, and through microscopes and telescopes? Ways to tap power from the magnetism of the Earth itself? And, in your home, substitution of magnetic current --- who ever got a shock from it? --- for electric current? Pure dreams, all of them, today --- but some of them, perhaps, realities of 2044.

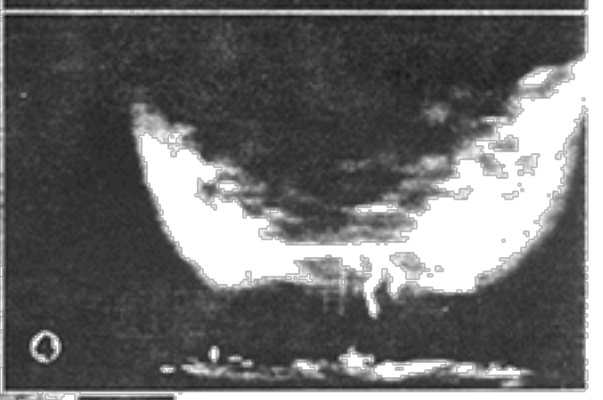
Before magnetic currents could be put in harness, of course, a myriad of questions about their behavior remain to be studied and answered. So far, no one knows whether they can be led through wires, like electric currnets, as well as through conducting liquids. If so, the wires might be of entirely different

materials than the best conductors for electricity. Likewise, the most effective insulators for magnetic current might be substances totally unlike those used for electrical insulators. The whole subject offers as vast a field for pioneering research as electricity did a century ago. And now, as then, an amateur experimenter puttering in his basement stands as good achance of making an epochal discovery as does a distinguished scientist in a great laboratory.

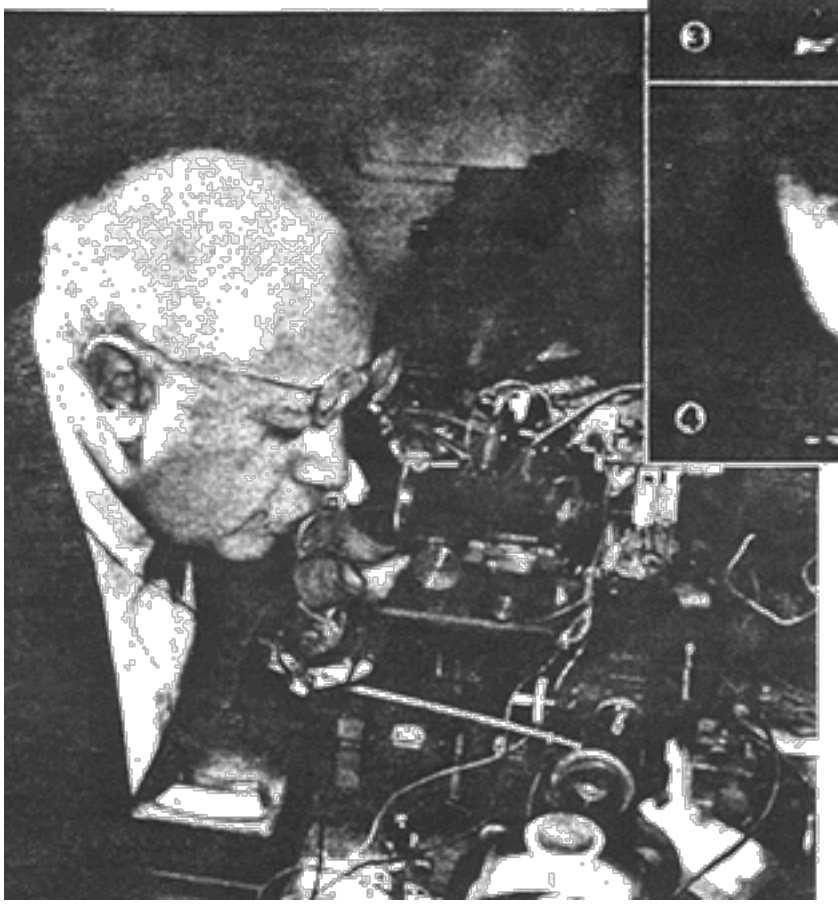


MAGNETIC DECOMPOSITION OF WATER? Using this simple apparatus, Dr. Ehrenhaft reports, he performs the "impossible" experiment of taking water to pieces with a permanent magnet. This magnet, of horseshoe shape, is seen at the bottom of the tube. Bubbles of gas rise from the metal poles sealed in the tube and are led to water-filled beakers, where they are collected for analysis. Both hydrogen and oxygen are found to be present, most of the oxygen coming from above the north pole of the magnet. A length of wire short-circuits the ends of the magnet to rule out any difference of electrical potential. The drawing at the right shows the details of the setup for this startling test

A glass cell, heart of the apparatus below, contains poles of an electromagnet, acidulated water



These photomicrographs, made by Alvin P. Freeman, show what happens in the cell. 1. With the magnet off, hydrogen bubbles liberated by chemical action rise from the pole pieces. 2. When the magnet is turned on, the poles attract or exchange bubbles. (Note the large bubble defying buoyancy to move downward from upper pole.) 3, 4. A whirligig of bubbles appears as a large white blur. Bubble tracks between the magnet poles suggest magnetic current. A conical upper pole aids in photography



Through a low-power microscope, mounted horizontally Dr. Ehrenhaft observes the goings-on in the glass cell. What he sees, photographed above, convinces him that he is watching hitherto unknown forces at play. A powerful beam of light from a projector is focused on the narrow gap between the pole pieces of the electromagnet to make the odd bubble dance visible

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(2) *Popular Science*, p. 208 (April 1945)

"Ehrenhaft Discovery Confirmed by New Experiments"

By observing whirligigs of electrically charges particles in a magnetic field, Brother Gabriel Kane of Manhattan College and Charles B. Reynolds of the Federal Communications Commission confirm the phenomenal discovery of magnetic currents by Dr. Felix Ehrenhaft (P.S.M., June 1944, p. 130). Going further, they make a drop of copper sulfate solution spin between the pole pieces of a permanent magnet, even rotating in interposed microscope cover glass with it. Present laboratory tests may lead to momentous applications in power machinery of the future.

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(3) Radio-Electronics (1978 ?)

"Lights That Failed"

Discovery of the Age? ~

In March 1944, *Radio-Craft* published an article, "Magnetic Current --- Discovery of the Age?". It described the work of refugee scientist Felix Ehrenhaft, Director of the Physics Institute, University of Vienna. Ehrenhaft believed that he had discovered particles with a one-pole magnetic charge (either N or S but not both). Beaming light on the gap between the poles of a powerful electromagnet, on the lower pole piece of which powdered metal had been scattered, he found that when the magnet was activated he could see some of the particles spring from the lower to the upper pole. Ehrenhaft believed that this indicated that they had a monopolar magnetic charge (Others were not so sure).

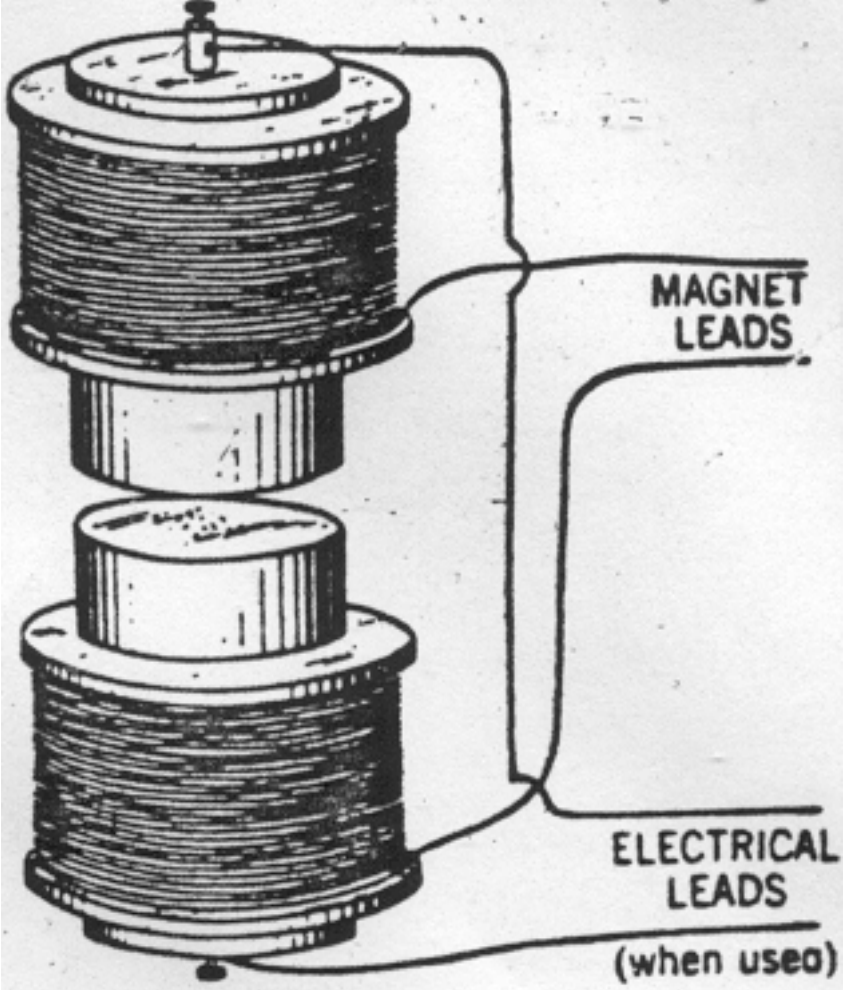
The work attracted a great deal of attention. *Radio-Craft* devoted two articles and an editorial to it. There is a gap in electromagnetic theory that would be filled neatly by monopole magnets and magnetic current, and students were extremely interested. Ehrenhaft made a number of other experiments that supported his hypothesis. Unfortunately one of the most dramatic ones --- indicating that water could be decomposed magnetically --- went wrong. It was absolutely unrepeatable. The professor was tremendously embarrassed, and to some extent withdrew from public discussion, carrying on his experimental work in the semi-seclusion of Manhattan College.

He returned to his post in Vienna after the war, and some of his later work was published in French and other scientific journals. He died not so long after, and interest in magnetic monopoles seemed to have died with him, until about 1970. Then one H.R. Kolm reported finding a track produced by a particle that was strongly accelerated in a magnetic field, something that might indicate a monopole magnet. He never published a formal paper on the subject, and presumably did not feel that he had enough evidence that a magnetic monopole existed.

In 1975, scientists of the University of California and of the University of Houstton (TX) reported the existence of a particle, far heavier than any yet discovered, that fitted the characteristics of a magnetic monopole as laid down theoretically by Dirac in 1931. For one thing Dirac had suggested that the particle --- if it existed --- should have a basic charge of 68.5 or a multiple of that number. The suspected particles had a charge of 137.

Three years later no further discoveries have been reported. An inquiry to Dr Alfred Goldhaber, who commented with interest on the 1975 discovery, reveals that though he has been doing theoretical work on the subject since 1975, "neither I nor anyone else has any evidence of the existence of magnetic monopoles". The final conclusion of the 1975 experimenters, he said, were that the track was not compatible with the magnetic monopole.

So the subject is still open. Theoretically, there is a place in the universe for magnetic monopoles, but apparently so far nobody has ever "seen" one.



ig. 2—The Ehrenhaft condenser. Magnetic o
electric fields may exist between its faces.

ADIO-CRAFT for MARCH
p. 332 1944

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(4) Leonard G. Cramp: *Space, Gravity, and the Flying Saucer* (pp. 154-156)

[Excerpt]

Here is an account of an experiment carried out by the well-known Viennese physicist Felix Ehrenhaft, whose work may prove to be an inspiration to students of this new approach to Kinematics.

Ehrenhaft and his colleague, Ernst Reeger, have proved that there is more than a little truth in the suspicion that tiny particles of dust tend to rotate when exposed to the rays of the sun. For they have not only reproduced this phenomenon in the laboratory, but they have succeeded in photographing it as well. In order to do this, Ehrenhaft placed tiny graphite particles into a glass flask, from which the air was completely evacuated. Then the flask was exposed to focused beams of sunlight. Instantly a large number of particles were seen to rise from the bottom of the flask and start to weave elliptical, circular and spiral-shaped paths, which were quite visible to the naked eye. The phenomenon ceased as soon as the light was weakened or cut off completely. Photographs taken at one-fifth and one-tenth of a second proved that not only were the particles orbiting, but more significantly, they were spinning on their own axis.

It is of interest to note that Ehrenhaft would like to relate the phenomenon to his own theory of a new type of physical force. He suggests that it is a purely ‘magnetic’ force which permeates throughout the known universe.

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(5) *Electric Spacecraft Journal* (July/Aug/Sept 1991), pp. 18-23) ~

"Magnetic Currents --- The Monopole?"

By Kristen Joseph

The following is a review of the work of Felix Ehrenhaft, affiliated with the Physical Institute at the State University of Vienna for most of his career. He began as an assistant professor in 1907 and held the post of director by 1920. In 1938 he left Austria for the United States and became a citizen the following year. In 1944, at a conference at Columbia University, where he had a lab, he revealed his various theories. Six months later Ehrenhaft gave further evidence of magnetic monopoles at a conference of the American Physical Society at Rochester University. He died in Vienna in 1952 at the age of 73.

We thank Jennifer Piel for graciously providing the reference material for this article.

Ehrenhaft was head of the Physical Institute of the State University of Vienna until shortly after Germany took Austria in 1938. He experimented with the behavior of minute particles under intense illumination in a field of electricity. His work began to suggest that a light wave carries tiny, energizing power stations of varying magnitude and pole, which could transfer energy and charge to particles of matter in the path of that light. He showed that light could propel matter and, later on, that ultraviolet light, for instance, magnetizes iron.

In measuring the effects that these power stations in a light wave have on ions, Ehrenhaft used a very small condenser and was able to measure forces a small as 1^{-10} dynes, determining charges on particles to be 2.9 x 1^{-10} esu, which is considerably smaller than the –1.60 x 10^{-19} coulomb (4.8 x 10^{-10} esu) that his contemporary Millikan attributed to the electron --- the value science accepts as standard to this day.

Micro-Manipulation ~

He worked with particles so exceedingly small (10^{-4} to 10^{-5} cm diam., +/- 0.1 to 1 micron) that several had to be lined up by micromanipulation before their end-to-end diameters added up enough to be measured, and it was perhaps because such extremely complex calculations went into measuring the charges on those particles that scientists in Ehrenhaft's day discounted the final results of his experiments, which he concluded in 1937.

Single Poles ~

But perhaps of greatest impact is Ehrenhaft's discovery, through numerous verifiable experiments using light, minute particles and magnetic fields, that magnets appear to carry a single pole, and therefore, that a magnetic current exists separately from the static magnetism of a magnetic field.

Conventional wisdom has it that magnetic poles always occur in pairs of opposites and that it is not possible for a magnetized object to have a north pole without an attached south pole.

Peregrinus ~

Based on the experiment reportedly done by Petrus Peregrinus in 1629, if a magnet is broken, new poles appear near the break in such a way that each pole has two opposite poles as well.

Ehrenhaft identified the problem with that crude experiment --- the lodestone Peregrinus put on a cork and floated in a bowl of water had too little mobility with respect to the geomagnetic field, and the very act of breaking it in pieces created magnetism through friction.

When Ehrenhaft repeated this experiment with very sensitive equipment, particles of microscopic size and a strong homogeneous field, he got different results.

Ehrenhaft set up a condenser with plates 8 mm in diameter and about 2 mm apart on the face of iron cylinders, thereby creating a vertical magnetic field that could be reversed at will.

He also could apply a reversible electric field if needed, going in the same direction but independent of the magnetic field. All observations were made with a dark field microscope. With his assistant, Leo Banet, he reported the following effects in the September 4, 1942 issue of Science:

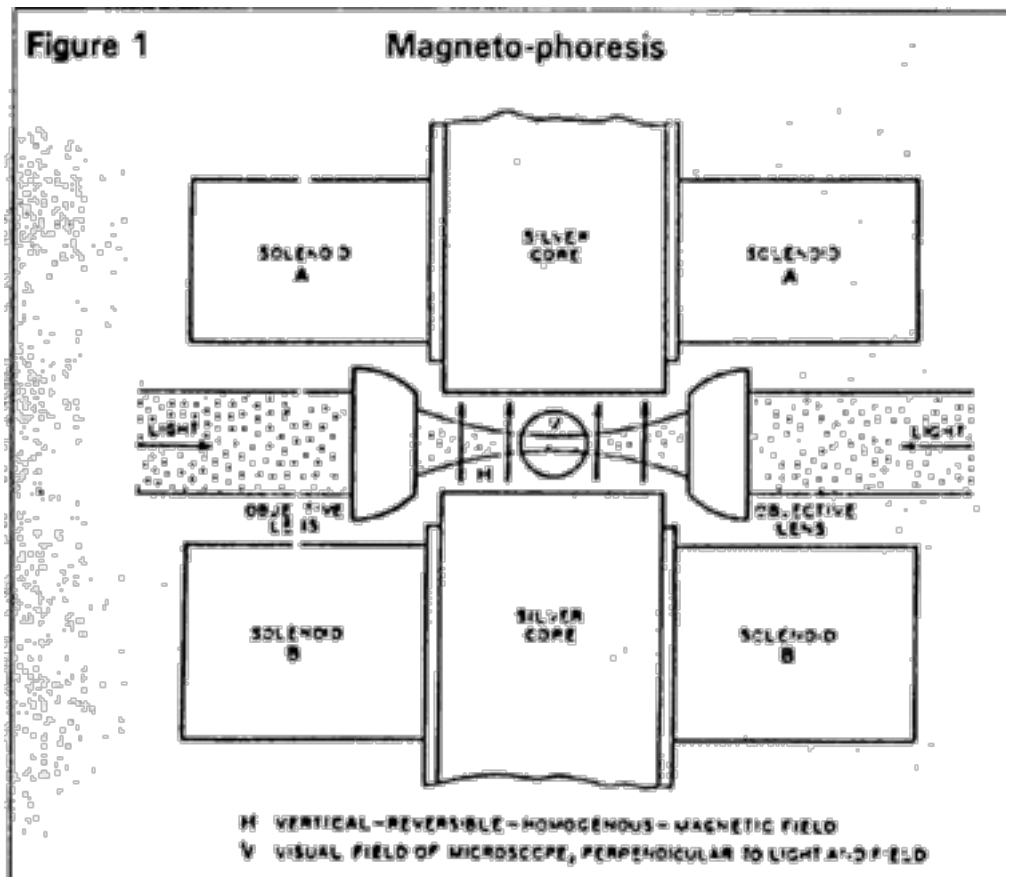
"If one places a minute amount of very fine powder, such as Fe, Ni, Mn, Cr, Sb in the exact center of the lower magnetrode, one can see, as soon as the magnetic field is applied, that some of the particles move toward the upper plate, while others remain at rest. It is also possible to place some particles on the upper plate, while others remain at rest. It is also possible to place some particles on the upper plate only. Of these, some move toward the lower magnetrode as soon as the magnetic field is applied, while the others remain at rest. It is even possible to combine both experiments at the same time. One then observes that some of the particles move toward the N and some toward the S magnetrode, carrying charges opposite to those of the plates to which they move. The particles arrange themselves on the magnetrodes in the direction of the lines of force and in needle-like masses parallel to each other and perpendicular to the plates". (Ref. !4)

Magneto-Phoresis ~

He reported similar polarization of the particles regardless of whether they were suspended in gas or liquid, and they behaved similarly when they were placed in either the homogenous electric or magnetic field:

"However, the difference could be particularly well noticed on Cu particles, which moved only in electric fields but not in magnetic ones, and on some iron particles which moved in magnetic particles but not in electric ones" (Ref. 14).

Also, some particles seemed to spontaneously change direction, and some seemed to tremble or waver between moving in either direction, and Ehrenhaft attributed this to a spontaneous change in magnetic charge on these particles. He dubbed the entire phenomenon ‘magneto-phoresis’ (See Figure 1).



Ampere Refuted ~

Ehrenhaft’s discovery of these magnetic ions refuted Ampere’s hypothesis that the effects of a magnet can be substituted by circular electric currents. Ampere’s electromagnets have two poles. Ehrenhaft showed that some particles behave like monopoles. To substantiate his claim that he had discovered magnetic ions, and thus magnetic current, he set out to show that magnetic current could produce the same effect as electric current --- that the magnetic current would cause electric ions to rotate around it in line of circular

force.

Like electric ions or current, magnetic ions would do chemical work.

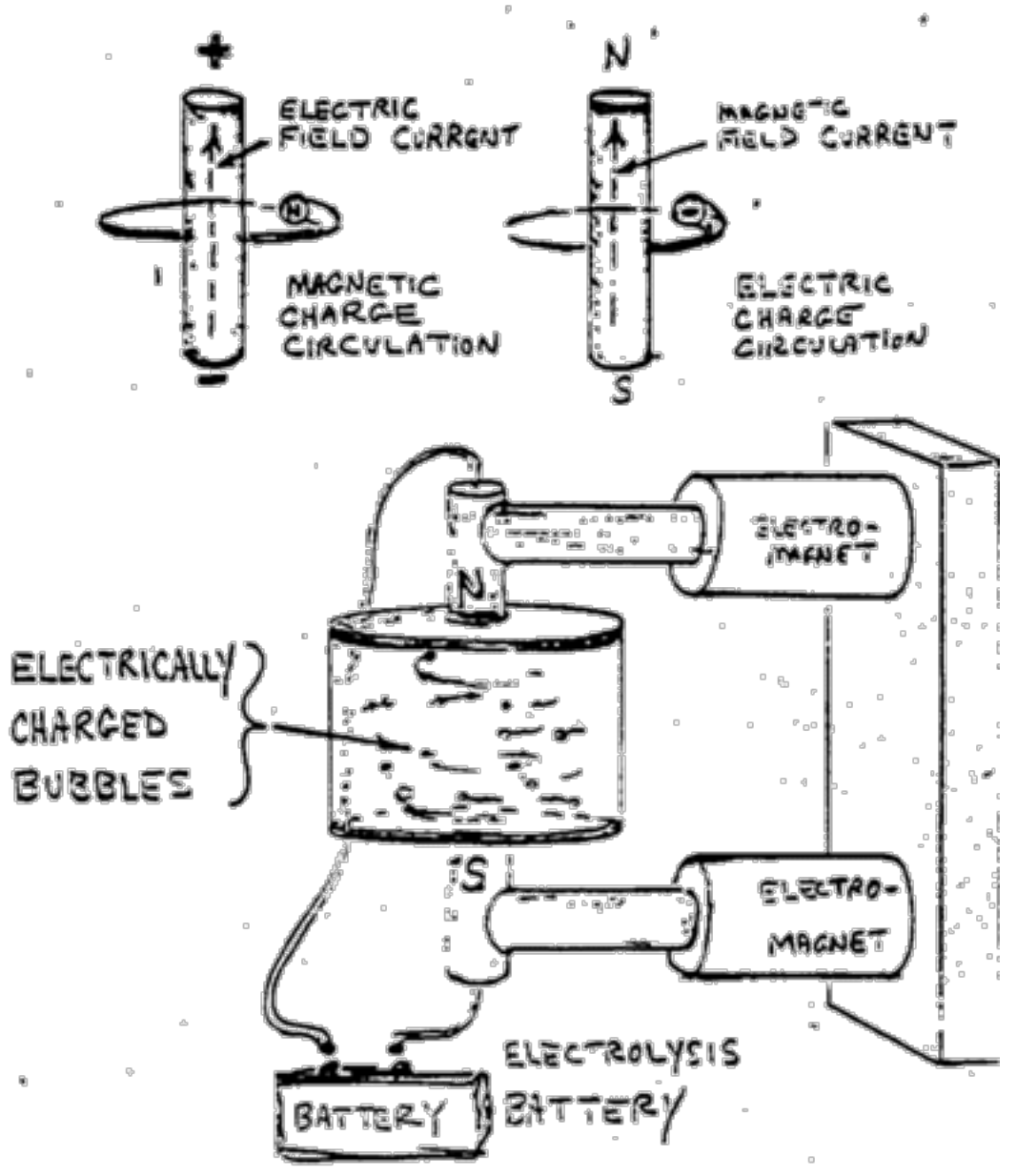
If he is right, the process of electrolysis, or decomposing water using electric poles (that had proven the existence of electric ions) could be made to happen in a magnetic field, thereby achieving magnetolysis and proving magnetic current by the same criteria.

To accomplish that experimentally, Ehrenhaft set up an electromagnet with soft iron poles that faced into dilute sulfuric acid, electrically insulated from the iron magnet core (See Figure 2). As one observer noted:

"When a little electric current was applied, the dilute acid was, of course, electrolyzed, and streams of bubbles rose from the poles. These bubbles, naturally, were electrically charged; the poles from which they evolved were charged. If the magnetic current existed, and if it could be made to flow from pole to pole through the acid solution, then the bubbles should, on the basis of theory, go into rotation around the unseen magnetic current.

"When the electromagnet was turned on, the rising bubbles instantly and violently twisted into a rapid rotation --- rapid and violent to be far beyond any question of accidental eddies of liquid convection or anything else. Reversing the magnetic current stopped the rotation then started it equally rapidly in the opposite direction".

Figure 2 *(1)*



Magnetolysis Experiment

Magnetolysis ~

There remained the question of magnetolysis that Ehrenhaft demonstrated using the same electromagnetic setup. This time, however, he short-circuited the two magnetrodes by linking them with a piece of wire, thus making electrolysis impossible. When the magnetic field was turned on, the natural slow evolution of bubbles speeded up; when collected and evaluated after some time a respectable percentage of those bubbles were found to be oxygen.

Ehrenhaft gave details of the experiment in *Physical Review* in 1943:

"Between the vertical cylindrical poles (magnetrodes) of an electromagnet of soft Swedish iron, whose bases form a horizontal gap (pole diameter 8 mm, gap 1-2 mm) acidulated water (1% sulfuric acid by volume) is decomposed into oxygen and hydrogen gas... As long as the two poles immersed in the solution are not magnetized, we get pure hydrogen, but as soon as the two poles are magnetized, we get a mixture of hydrogen and oxygen (about 2-12% oxygen)". (Ref. 8)

Since chemical action alone would not yield oxygen, some additional process was at work breaking down the water to its elements.

Ehrenhaft continued:

"Microscopic observation shows that the magnetically evolved gas bubbles carry either a N or S magnetic charge... Each of these positive charged gas bubbles moves in a circle around the gap between the magnetrodes, through which a constant magnetic currnet flows, reversing its direction on reversion of the magnetic field, exactly as a single magnetic pole would circulate around the constant electric current, reversing its direction with the reversal of the electric field". (Ref. 8)

Magnetic Current ~

Ehrenhaft discovered that a magnetic current is surrounded by circular electric lines of force and that the magnetic charge of the magnet could be set free by making it release oxygen gas from acidulated water.

Interestingly, as John W. Campbell, Jr. pointed out in his article on Ehrenhaft in the May 1944 issue of *Astounding Science Fiction*, electrically charged particles do not rotate detectably around the gap between the poles of a permanent magnet. He noted the reason for this was: "[T]he permanent magnet represents stored magnetic energy --- static magnetic field energy, pretty solidly tied down", similar to an electret, the magnet's counterpart (The electret has stored electric-field energy that it cannot release as current). "The permanent magnet does not, therefore, have a magnetic current associated with it. The observed lack of rotation, then, conforms with theory". (Ref. 1)

Measuring Magnetic Current ~

Assuming the existence of magnetic current, Ehrenhaft wanted to measure it, and he did it the same way Ampere first quantified the nature of electric current. Ampere stated that a single magnetic pole would whirl around a wire carrying an electric current, the intensity of which was measured by the work done by carrying a unit magnetic pole once around the entire electric current.

In an experiment described in *Physical Review* 1944 (Ref. 12), Ehrenhaft learned that permanent magnets lose a portion of their pole strength during the magnetolysis process:

"Dr Ehrenhaft has set up an alnico magnet, and drained the pole strength by approximately 10% in 60 hours in one case, and with another magnet the same pole-strength reduction was accomplished in 24 hours". (Ref. 1)

This is the counterpart of the loss in pole-strength of Volta's pile during electrolysis, indicating the average intensity of the magnetic current flowing between the pole faces in what Ehrenhaft termed "absolute magneto-static units" or msu. In the magnetic version of Ampere's statement, he observed:

"The intensity of the magnetic current measured electrically is equal to the work done in carrying a unit electric charge once about the electromagnetic current". (Ref. 5)

For example, the numerical value of the magnetic charge on a single particle of nickel in gas could be smaller than 5×1^{-10} msu.

Electric and Magnetic Charges ~

In subsequent experiments Ehrenhaft established that particles can carry both electric and magnetic charges at the same time as evidenced by their motion in gas or liquid. He theorized that the magnetic charge equaled the electric charge on particles of the same size. In one experiment, the particles rotated around the magnetic current because of their electric charges. Because of their magnetic charges, bubbles moved either upeard or downward. Their resulting path was a helix and could be seen "even by the naked eye to be circulating in a counterclockwise direction, when looking upon the face of the S pole. This movement carried the bubbles downward, even against the force of buoyancy". (Ref. 12)

The Third Force ~

The ramifications of what Ehrenhaft discovered can only be guessed at:

"It is the belief today that there exist in nature only two general forces, the force of gravity and the magnetic action of electric currents. But we have here a third force, the electric action of magnetic currents". (Ref. 12)

In the same letter to the editors of *Physical Review*, he wrote:

"Oersted found... a vortex around the wire connecting the two poles of Volta's pile. The phenomena here reported show that there is a vortex around the poles of an electro- or permanent magnet. In Oersted's experiment, the pile lost its pole strength. In the experiment with the permanent magnet, the magnet lost its pole strength. In Oersted's experiment, we have to deal with electrodynamic rotations. In the new case, we have to deal with magnetodynamic rotations. Both rotations are the result of the expenditure of energy, one from Volta's pile, the other from the magnet.

"If the single magnetic pole is fixed and alone in action, the opposite pole being remote as is done in Faraday's experiment, and the wire conducting the electric current is free to move, the wire will rotate around the single pole. This is the principle of the electric motor...

"In the new case... we have two fixed magnetic poles with the electrically charged matter free to rotate around the magnetic current. This is, in principio, the magnetic motor. We are here using our third force. One cannot tell how a motor operated by this force can be utilized". (Ref. 12)

Magnetic Motors ~

Science writer John W. Campbell, Jr, however, envisioned magnetic charges with mutual attraction forces equivalent to millions of volts operating in small practical machines. He speculated that, "A magneto-electret --- consisting of a coil of magnetic conductor carrying a heavy magnetic current --- would develop electric potentials that did not tend to arc across. Perhaps a small magnetic coil would develop 50,000,000 volt potentials that could tear atoms apart". (Ref. 1)

Twins ~

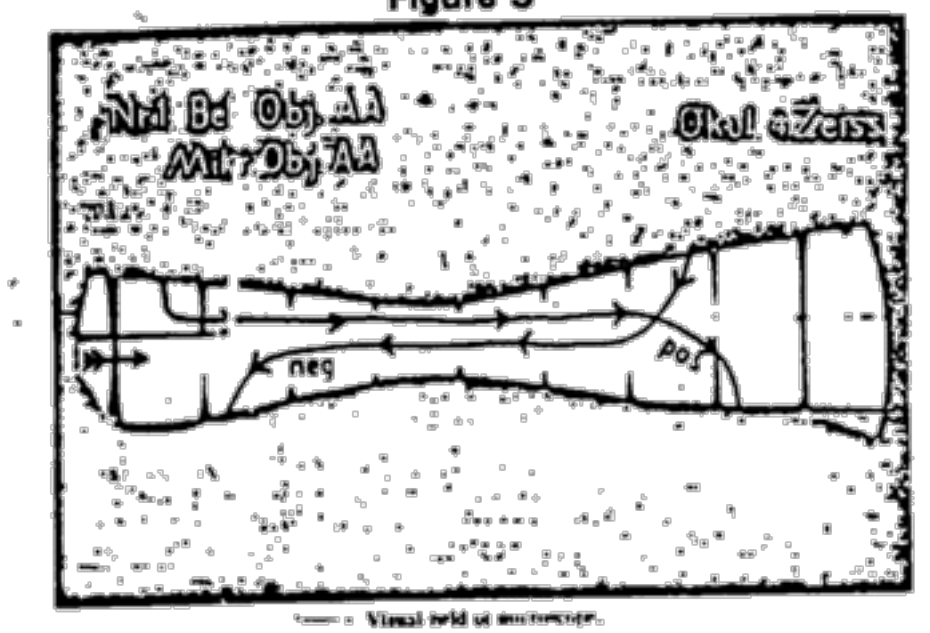
But perhaps of far greater importance, Ehrenhaft pointed out, "is the necessity to define more clearly the part that the inseparable twins, electricity and magnetism, play in their interaction, one on another, and to determine if, in the future, they can best be defined by one symbol only" (Ref. 12).

Conclusion ~

Ehrenhaft's work with the effects of intense light beams on small particles was never conclusive. He did show, however, that light beams of short frequency could repel and attract some small particles; that matter thus excited by light tended to move along magnetic lines of force much like he speculated that the gases in a star's corona took shape as though surrounding a magnetized sphere.

He pointed out that the intense light and magnetic current flowing from the sun to the earth along the lines of force of the Earth's magnetic field was likely creating the aurora borealis and other magnetic effects still little understood today.

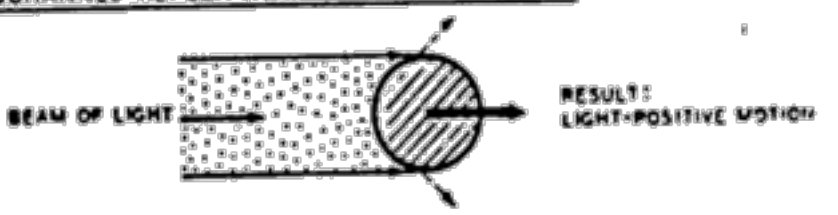
Figure 3



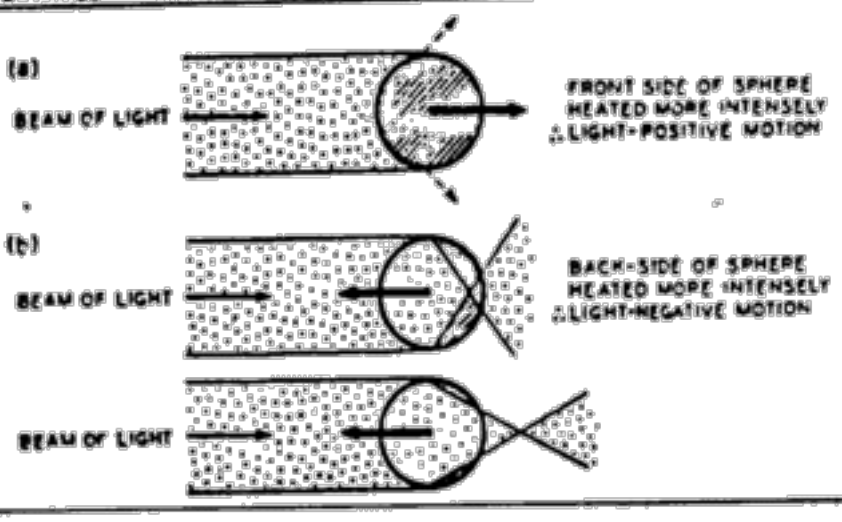
Visual field of microscope.

FIG. 6.

1 JOHANNES KEPLER (1619): PRESSURE OF LIGHT



2 SIR WILLIAM CROOKES (1874): RADIOMETER FORCES



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"Stationary Electric and Magnetic Fields in Beams of Light"

Felix Ehrenhaft

According to then electromagnetic theory of light (Maxwell, Hertz) the electric light vector and the magnetic light vector oscillate perpendicularly to the direction of propagation. The energy of the wave is given by Poynting's vector.

It is shown below, on the basis of experimental findings, that every wave of light possesses likewise a stationary field intensity E in its direction of propagation and also the stationary magnetic field of intensity H. That means there is a potential difference between two points on the ray of light. Accordingly, it should be possible to collect electricity from the ray under suitable conditions. A beam of light therefore constitutes a source of electricity; furthermore, light has magnetizing effects.

Experimental proof of this generalization was obtained from my investigations of the interaction between light and small particles of matter (*Ann. Phys.* 18: 151). This permits of the measurement of forces of the order of 10^{-9} to 10^{-19} dynes. The sensitivity of measurements of forces is thus increased by my methods by a factor of 1,000-10,000

When particles of matter are irradiated by sufficiently intense light of sufficiently small wavelength, regardless of the direction of the wave front normal, then positive or negative electric charges, or north or south magnetic poles, are induced on these particles. Particles of otherwise identical properties move in a homogeneous electric or in a homeogeous magnetic field in or against the direction of the electric field (electro-photophoresis), or in or against the direction of the magnetic field (magneto-photophoresis). These induced temporary electric or magnetic ions exist as long as the particles are irradiated by sufficiently intense light. Furthermore, it can be observed that some particles stay at rest and that their motion commences suddenly,or that moving particles appear to change their velocity and even reverse it. These are due to changes of charge. The movement of magnetic ions in a homogenous magnetic field is a 'magnetic currnet'.

These phenomena are best observed when two fully symmetrical beams of light are directed against each other and when the fields act perpendicularly, are reversible and free from residual magnetism and electricity, and are also homogeneous. The intensity of this motion depends upon the frequency of the light wave. It increases with increasing frequency and is also dependent on the material. I have also found that, when using just one concentrated beam of light, without any field, small particles of matter of magnitude 10^{-4} to 1^{-5} cm of the same kind as before moved in clean gases either away from the source of light (light-positive, longitudinal photophoresis) or towards the source of light (light negative, longitudinal photophoresis). This force increases with the intensity of the light and likewise depends upon frequency and material.

There are particles which do not show longitudinal photophoresis at first, but only after a certain time, and some which gradually lose it. I have shown in another paper also that radiometer forces cannot account for these effects (*J. Franklin Inst*. 230: 381). Longitudinal photophoresis has also been found in liquids with particles of the same material. These particles moved in opposite directions.

Since light makes particles of matter unipolar with respect to homogeneous electric fields, and since, when no such fields act, it makes them move in or against the direction of its wave front normal, there must be an electric field E coincident with the direction of the wave front normal. This means that electromagnetic waves possess longitudinal stationary components of E, and therefore potential differences between different points along the beam. The magnitude of those fields can be calculated from actual measurements.

These facs have been confirmed by further experiments by myself and some of my pupils. An electric field suitably arranged parallel to the wave front normal permits the acceleration or retardation or even reversal of positive or negative photophoresis. The superposed field alters the component of the electromotive force in the direction of the beam.

From similar experiments it can be concluded that stationary magnetic fields exist in the beam of light, since superposed magnetic fields accelerate or retard the magneto-photophoresis. Those stationary magnetic fields in the beam of light have a magnetizing effect on the material as above mentioned.

In conclusion, I find that light beams have electric stationary components in the direction of the wave front normal, and that consequently there must be stationary electric potential differences between different points along the beam. There must also be a stationary magnetic field in the beam of light with potential differences.

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(7) *Nature* (March 8, 1941), p. 297 ~

"Magnetization of Matter by Light"

F. Ehrenhaft // Leo Banet

One of us (F.E.) has shown that small particles of matter of different chemical elements, but of the same physical qualities, irradiated by concentrated light, move in a homogeneous magnetic field, some of them toward the N, some toward the S pole (magnetrode). Therefore, there must be a preponderance of either N or S magnetism on each of these irradiated particles, and they behave like single magnetic poles (charges) (Ref. 1). Further, experiment led to the conclusion (Ref. 2) that, in addition to the oscillating electric and magnetic vectors, light beams must have electric stationary components in the direction of the wave front normal, and that consequently there must be stationary electric potential differences between different points along the beam; and that there must be also a stationary magnetic field in the beam of light with potential differences. Hence, the light beam must have a magnetizing effect, and the charge of a magnet should be changed by light.

Examination of the literature showed that even before the time of Oerstedt's experiments, Domenico

Morichini (Ref. 3) in 1812 magnetized compass needles by means of the ultraviolet portion of the spectrum of sunlight as used by Herschel. His experiments were verified by M. Sommerville (Ref. 4), F. Zantedeschi (Ref. 5), V. Baumgartner (Ref. 6) and others.

We therefore undertook to test the photomagnetic effect also on larger bodies in continuation of the above-mentioned fundamental experiments in continuation of the microscopic bodies (magneto-photophoresis), through which the general magnetization of the elements and the existence of magnetic 'currents' was brought to light. The experiments were successful with the simplest apparatus, undertaken in a private apartment with a 10 cent compass needle from Woolworth's as an indicator, and using a beam of light rich in ultraviolet radiation (Hanovia mercury arc, Max=zda GE daylight bulb) which was contained by means of quartz lesnes.

Magnetic poles (charges) were induced in various non-magnetic and annealed pieces of iron (paperclips, nails,little iron rods), which were placed perpendicularly to the geomagnetic field, by irradiation for periods varying from minutes to several hours. Those poles were mainly N magnetic and were still present in many specimens after several days.

After short periods of irradiation, it could be shown that the effect was local and on the surface. After long irradiation periods saturation values were obtained.

We also convinced ourselves by means of an amplifier and oscillograph that the characteristic of an induction coil with an iron core changed under ultraviolet irradiation.

Naturally, the magnetization was also dependent upon the material, its surface and history to a very high degree. Further investigations are in progress.

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"Rotating Action on Matter in a Beam of Light"

Felix Ehrenhaft

Referring to the paper read by me on January 19, 1945 at the New York meeting of the American Physical Society, G.F. Hull (Ref. 1) has clearly understood that my claims are new, as he says "that he (Ehrenhaft) had claimed to prove that a beam of natural (unpolarized) light produces a rotating action on matter", while, as Hull states later on according to his textbook, "the rotating action in a beam of circularly polarized light is exceedingly small, and in a beam of natural light nothing whatever".

When Lebedew (Ref. 2) and Nichols and Hull (Ref. 3) worked, forces only down to 10^{-5} or 10^{-6} dyne could be measured (Ref. 4). In 1909 I developed a method of measurement of forces exerted in single microscopic or submicroscopic bodies which enable the measurement of forces as small as 10^{-10} dyne

and applied it for the determination of the size and the electric charge of single spherical particles of well-known density (Ref. 5). This was next used by K. Przibram (Ref. 6) in the measurement of the electric charge on single droplets of mist and later by others on oil drops. This method, 10^4 times more sensitive than former methods, has resulted in the detection of phenomena concerning the interaction between radiation and matter which I termed 'photophoresis'. In a concentrated beam of natural light, test bodies of the same size and with the same physical properties move simultaneously with the direction of propagation of the radiation (light positive) and against this direction (light negative). Radiometer forces of the Crookes type or similar effects cannot be accountable for the observed facts (Ref. 8, 9).

The above movements can be influenced by the superposition of homogeneous magnetic or electric fields (magneto-photophoresis, electro-photophoresis). Particels irradiated by light do move in the homogeneous magnetic fields and reverse their direction of movement with the reversal of the field as often as desired. It must be concluded that they carry an excess of N or S magnetic charge. Many of the test bodies exhibiting a magnetic charge in the light retain this charge in the dark (Ref. 10). Thus, expanding the terminology of Faraday, there exists a magnetic ion in general and consequently a magnetic current. The electric action of magnetic currents, the counterpart of the magnetic action of electric currents has been demonstrated (Ref. 11). His means that the single electric charge (pole) rotates around the magnetic current and that the single magnetic charge (pole) rotates around the electric current (Oersted-Ampere).

In my recent measurements of single magnetic charges on microscopic particles, I separated the influence of light from the influence of the magnetic field by measuring these charges in the dark (Ref. 12). I further investigated again the ponderomotive force of light upon matter. If one introduces and allows to fall into a vertically projected beam particles of, for instance, Cr, Fe, Mn, Cu^2O, those of a size of about the wavelength of light and smaller fall vertically, while those of more than the wavelength of light in size describe in falling distinct helical paths in the beam of light, as already observed by me and my school in Vienna and Whytlaw-Gray (Leeds)(Ref. 8) in the horizontal beam. Whytlaw-Gray has repeated my experiments and obtained identical results.

In my recent experiments made with Richard Whitall it was determined that often the bodies made five to ten revolutions per second around the axis of the helix, and the radius of this helical path is exceedingly large compared with the radius of the body. These facts can be easily understood. Optically active substances rotate the plane of polarization of light, and Faraday (1845) succeeded in rotating the plane of polarization by applying a magnetic field parallel to the beam.

The helical paths have been observed with linear polarized light as well as with natural light, and without parallel external magnetic field. This is to be expected, since the light scattered by a spherical body is for the most part linear polarized, and since our magneto-photophoresis experiments demonstrate that in the direction of the light beam there exists a static longitudinal magnetic field analogous to the electrostatic field therein produced by Woldemar Voigt (Ref. 13). These fields can explain in some respect electro- and magneto-photophoresis with the movement of electrically charged bodies in the longitudinal magnetic field of the beam of light. Concerning the helical movement in the beam of light, the electric charge rotates around the longitudinal magnetic field and vice versa.

The helical movement of particles observed by me and Whytlaw-Gray cannot be explained by the formulation of Maxwell-Poynting, on which point of view G.F. Hull has based his work on light pressure.

It has been found that light rotates matter, if matter is free to move with 3 degrees of freedom. The well-known principles of conservation of linear and angular momentum of electrodynamics (Poincare, Max Abraham) do not cover the experimental facts that light can exert forces of attraction, repulsion and torsion. Regarding the general theoretical conclusions it is evident that we have to add to the electrodynamic equations the expression for the true single magnetic charge and therefore the term for the magnetic current (Ref. 14). The formulations have to be broadened in such a way as to include the three actions listed above.

These observed actions require a modification of the relation E = MC^2, pronounced for the first time by Hasenoehrl (1904) for the radiation of black bodies (Ref. 15), generalized later on, as well as a revision of the more modern concepts which have been derived from the enunciation of A. Soldner (1801), entitled 'About the Deflection of a Beam of Light from its Rectilinear Movement through the Attraction of a Celestial Body Near Which the Beam Passes' (Ref. 16). In considering astrophysical questions it is clear that one must take into account not only the repulsive force of radiation but also the attractive and rotational forces.

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"New Evidence of the Existence of Charges Smaller than the Electron"

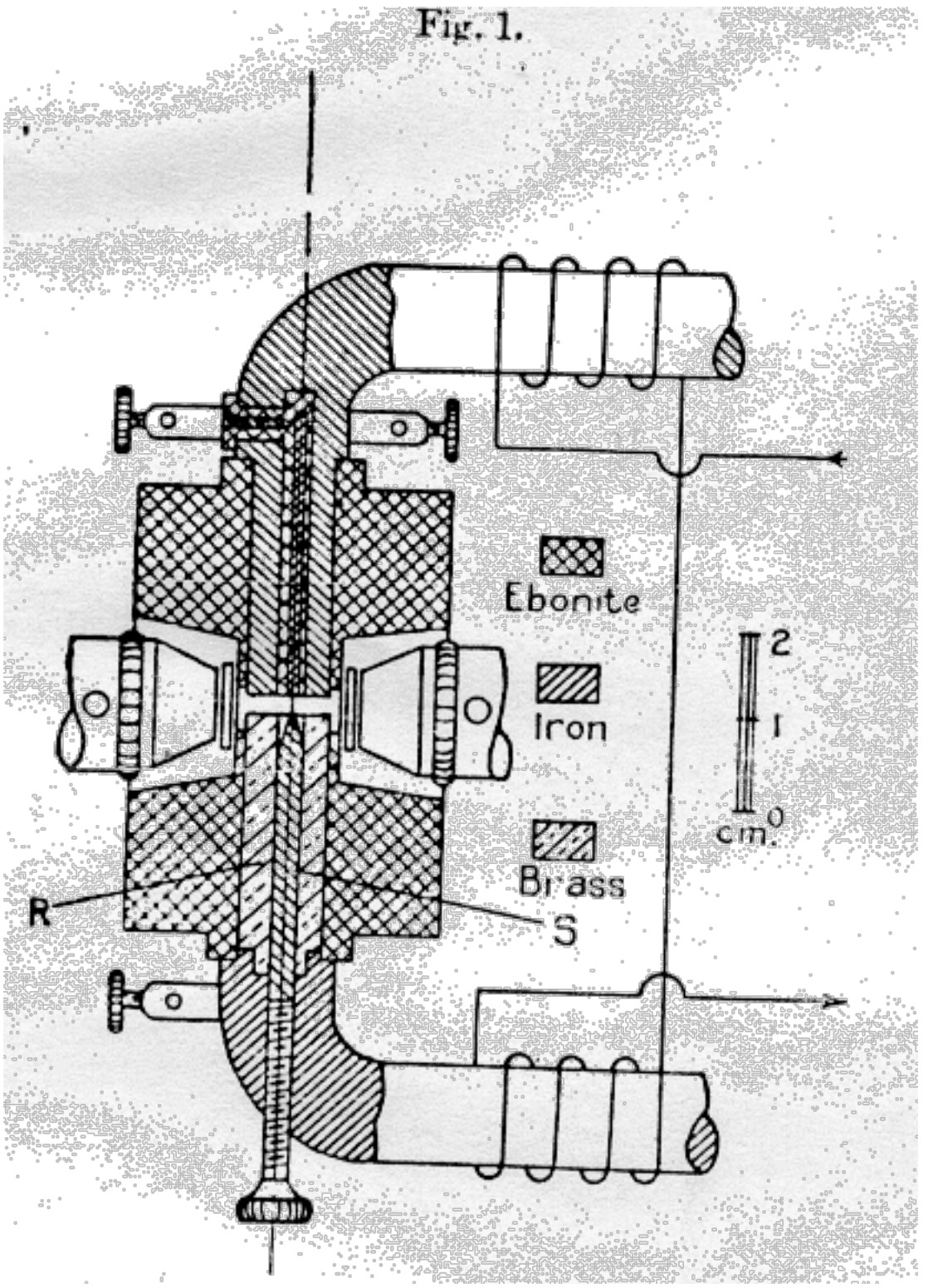
Felix Ehrenhaft

[Excerpt]

Section 2: The Micromagnet ~

In the following measurements the circular poles of an Ehrenhaft condenser of the diameter of 9 mm were rebuilt into poles of a strong electromagnet. The upper plate consists of a hollow cylinder of soft iron with an external diameter of 9 mm. and an internal diameter of 2 mm. Into this is introduced an electric insulated solid cylinder of the same iron with a diameter of 1 mm. These cylinders can be brought to various electric potentials. The lower plate ends in a conical iron pin, 2 mm thick, which has a circular base with a diameter of 1 mm. The pin is surrounded by a mantle of brass with a diameter of 9 mm, so that its base lies in the same plane as that of the pin. The described condenser plates go over into two iron cores (12 mm thick, 190 mm long), each of which is wound with 14 layers of 2 mm copper wire. An accumulator battery of 120volts cross-potential and very great capacity furnishes a quite constant current. The number of ampere turns per 1 cm is 1080. The two cores are closed by an iron yoke which is insulated from them by leaves of mica. In this way the plates can also be used as an electrical condenser. Four coolers fed with flowing water, two for each core, provide for a sufficient removal of the heat and hold the temperature constant. When the windings are connected with the electrical circuit, there are produced two opposite magnetic poles in the vertical x axis. In this way we get a symmetrical inhomogeneous magnetic field between the plates of an Ehrenhaft condenser, which are at a distance of 1.8 mm apart.

Fig. 1.



Keelynet Discussion Notes:

Felix Ehrenhaft: Micro-Magnet & Sub-Electron

http://www.keelynet.com/interact/archive/00001672.htm.*(29 Nov 1999)*

The premiere investigator into the effect of magnets to promote dissociation of water was Professor Ehrenhaft. This ties in with Stan Meyers claims of 'fractioning' water and Randoll Mills claims of a 'hydrino' which is based on a fractional hydrogen charge...kind of a SUB-isotope of hydrogen.

http://paranetinfo.com/mainbbs/space/TESLA.TXT

Ehrenhaft discovered and reported fractional charges for years, in the 30's and 40's, and was ignored. See P.A.M. Dirac, "Development of the Physicist's Conception of Nature", *Symposium on the Development of the Physicist's Conception of Nature*, ed. Jagdish Merha, D. Reidel, Boston, 1973, pp. 12-14 for a presentation of some of Ehrenhaft's results. Within the last few years Stanford University researchers have also positively demonstrated the existence of "fractional charge." For a layman's description of their work, see "A Spector Haunting Physics," Science News, Vol. 119, January 31, 1981, pp. 68-69. Indeed, Dirac in his referenced article points out that Millikan himself -- in his original oildrop experiments -- reported one measurement of fractional charge, but discounted it as probably due to error.

http://www.centuryinter.net/tjs11/bus/magnh2o.htm

For his "impossible" experiment, Dr. Ehrenhaft employs the simplest of apparatus. Two shiny rods of pure Swedish iron, sealed in holes through opposite sides of a U-shaped tube, resemble a setup familiar to high-school students for breaking up water into hydrogen and oxygen gases by passing electricity through it. And that is exactly what would happen if Dr. Ehrenhaft attached electric wires from a battery to the rods. But he does no such thing.

Instead, he uses the iron rods as pole pieces, or "north" and "south" ends, of a magnet -- either an electromagnet or a permanent magnet. Bubbles of gas rise through the twin columns of acidulated water, to be collected and analyzed. As might be expected, nearly all of the gas is hydrogen, liberated by a commonplace chemical interaction between the iron rods and the dilute sulfuric acid, one percent by volume, in the water. But the phenomenal part of the experiment is that oxygen also turns up, Dr. Ehrenhaft recently told the American Physical Society.

To be specific, it is found in clearly measurable proportions ranging from two to 12 percent of the total volume of gases. When the gases obtained with a permanent magnet are separated, the larger proportion of oxygen is found above the north pole of the magnet. After rigorous precautions -- including short-circuiting the magnet poles with wire, so that the poles will be at the same electric potential -- Dr. Ehrenhaft concludes that there is only one place the oxygen can possibly come from. And that is from water decomposed with a magnet! Without a magnet, pure hydrogen is evolved.

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http://www.sciencenews.org/sn_arch/10_5_96/timeline.htm

"SMALLER THAN ELECTRON"

New evidence that there is another world of almost infinite minuteness, beyond the electron which only recently replaced the atom as the smallest thing in the universe, was brought forward by Prof. Felix Ehrenhaft of Vienna University at the meeting of the Association of German Natural Scientists and Physicians.

Prof. Ehrenhaft's data were obtained by means of a new and highly powerful apparatus for the ultramicroscopic examination devised by himself, which makes possible the observation of particles far

below the limits of ordinary microscopic visibility, floating freely in a gaseous atmosphere in a magnetic field.

He observed in this magnetized submicroscopic field the behavior of globular bits of gaseous selenium with diameters of only 1/250,000 of an inch. Their rate of drift, under the influence of the magnet, indicated that the electric charges they carried were less than the equivalent of one electron. This would indicate, according to Prof. Ehrenhaft, that the electron is subdivisible, and therefore, that something smaller than the electron exists.

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http://faculty.millikin.edu/~jaskill.nsm.faculty.mu/e.html

Ehrenhaft was a supporter of the traditional view of matter, while Millikan held the view that matter was atomic in nature. Ehrenhaft's experiment used colloids and ultrascopic Brownian motion of individual fragments of metal. He was the first to determine a value for the electronic charge of 1.5×10^{-19} C in 1909.

Millikan, using his famous oil drop experiment, published an initial result in 1910, giving the charge on the electron a value of 1.3 x 10-19 C.

Subsequently, Ehrenhaft showed that his results indicated fractions of the electronic charge of 1/2, 1/5, 1/10, and 1/100 existed. At the time, no one was able to disprove Ehrenhaft's results or substantiate them. However, by 1913, Millikan had perfected his oil drop experiment and had concluded that the electronic charge had a singular value of 1.591×10^{-19} C.

Millikan's experimental results soon gathered the support of the most eminent physicists of the time including Planck and Einstein, and the atomic view of matter prevailed. He was awarded the Nobel Prize in Physics in 1923 for his work on measuring the charge on the electron. The best current value for the charge on the electron is e = $1.60217733 \times 10^{-19}$ C.

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http://www.wmich.edu/ethics/ESC/cs2.html

An examination of Millikan's own papers and notebooks reveals that he picked and chose among his drops. That is, he exercised discrimination with respect to which drops he would include in published accounts of the value of e, leaving many out. Sometimes he mentioned this fact, and sometimes he did not.

Of particular concern is the fact that in his 1913 paper, presenting the most complete account of his measurements of the charge on the electron, Millikan states &quotIt is to be remarked that this is not a selected group of drops but represents all of the drops experimented upon during 60 consecutive days."

Millikan's notebook appears to contradict this assertion. Of 189 observations during the period in question, only 140 are presented in the paper.

Millikan's results were contested by Felix Ehrenhaft, of the University of Vienna, who claimed to have found "subelectrons." Moreover, Ehrenhaft
claimed that his finding was in fact confirmed by some of Millikan's own data -- droplets that Millikan had mentioned but discounted in his published writings.

The result was a decades-long controversy, the "Battle over the Electron," over whether or not there existed subelectrons, or electrons with charges of different values. This controversy makes an excellent case study because we are fortunate, thanks to Millikan's notebooks, to be able to see very specifically which drops he included and which he did not.

In retrospect, we know that Millikan was "right" and Ehrenhaft "wrong." Electrons, to the best of our present experimental and theoretical knowledge, have a specific, discrete charge.

Those scientists and other scholars who have carefully reviewed this case have failed to agree on whether Millikan was guilty of unethical behavior or "bad science" in the treatment and presentation of his data.

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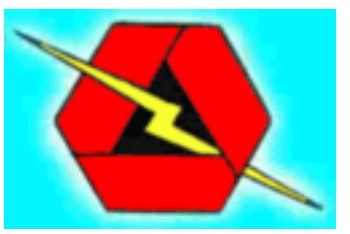

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