there was a change in the methods used in the volumes of the "Record of Science and Industry" for the years 1877 and 1878, which in Baird's own words was as follows:

A modification of the original plan of the "Annual Record" was commenced in the volume for 1877. Previous to that it consisted of two parts—first, a general summary of progress in the various branches of science; and, secondly, a series of abstracts of special papers, credited to the work in which they were published. These abstracts, although prepared by several specialists, were without indication of their authorship. The experience of several years showed that, in attempting to give abstracts of anything like the most important announcements of the year, more space was required than could be spared for the purpose; and it was therefore determined to enlarge the scope of the first division, and make it include a great amount of detail, each summary to be prepared by some eminent specialist, and to be headed by his name.

This plan was continued with the volume for 1878, the preface of which is dated March 1, 1879, but with this volume the series came to an end. These most admirable summaries were continued in the annual reports of the Smithsonian Institution and formed the most important feature of each of these valuable reports until the death of Baird.

Goode's work as a rule was superior and he seldom omitted an essential item in anything that he wrote, but I am sure that were he living, he would gladly permit me to add the word "editor" to the following description that he wrote of Baird:

He was one of those rare men, perhaps more frequently met with in the new world than elsewhere, who give the impression of being able to succeed in whatever they undertake. Although he chose to be a naturalist, and of necessity became an administrator, no one who knew him could doubt that he would have been equally eminent as a lawyer, physician, mechanic, historian, business man, soldier or statesman [and editor].

When the publication of the "Annual Record of Science and Industry" ceased with the volume of 1878, it seemed as if the sun had set, but not altogether, for here and there were bright spots in the sky. The *Scientific American*, founded in 1849, was devoted to the exposition of popular science. In 1876 it added its *Supplement* to give to the world a record of the progress in applied knowledge as manifested by the Centennial Exhibition held in that year in Philadelphia. It still lives in a more dignified dress as a well-edited and useful monthly.

Just above the horizon was the *Popular Science Monthly*, then edited by the gifted Edward L. Youmans and devoted to a higher grade of popular science than any of its predecessors. Later came SCIENCE, which has become probably the most important scientific journal ever published in the United States. All these have paved the way for a *Science News Service*, which, ably controlled by E. E. Slosson, again gives to the public statements of the progress and development of science that are as true, honest and reliable as those put forth by Spencer F. Baird.

MARCUS BENJAMIN

SOME PHYSICAL ASPECTS OF A RECENT ANALYSIS OF THE EARTH'S MAGNETIC FIELD[1]

THE difficulties to be met in the formation of any adequate theory of the origin of the earth's magnetism are in part mathematical, in part geometrical, because of the sphericity of the earth-magnet, but they arise chiefly from the physical conditions involved. No matter what theory is proposed somewhere a hypothesis must be introduced implying new properties of matter or physical conditions below and above the earth's surface, regarding which we have at present either no knowledge whatsoever or but the faintest glimpse. The same remarks apply to that other great problem of cosmical physics—the origin of the earth's electricity. It has accordingly been suggested that terrestrial magnetism and atmospheric electricity may reveal to us hitherto unknown properties of matter; for the properties which the rotating earth and the rotating sun may possess, because of their masses, sizes and angular velocities, may fail of detection with the experimental conditions possible in the laboratory.

The most complete and exhaustive analysis heretofore made of the earth's magnetic field, as based on the accumulated magnetic data of the Carnegie Institution of Washington and cooperating organizations, has just reached the preliminary stages of completion. We have now facts of sufficient reliability so that in a number of cases it is possible to say definitely that a theory advanced is not correct or at least not complete.

One of the definite disclosures of interest is that about 94 per cent. of the earth's magnetic field arises from systems of magnetic and electric forces inside the earth; about 3 per cent., except for possible relativity effects, is apparently to be referred to an electric system in our atmosphere, and the balance, about 3 per cent., to a system equivalent in its effects to electric currents passing perpendicularly through the earth's surface. Furthermore, we now know that the direction of the axis of the magnetic field of the earth, of the atmosphere and of the sun is related in the same way, for all three bodies, to the direction of

[1] Presented at the meeting of the American Philosophical Society, Philadelphia, April 21, 1923.

rotation of the body, and that the magnetic axis for each of the three bodies is inclined to the axis of rotation, namely, at present, 11.5° for the earth, about 14° for the atmosphere, and about 6° for the sun. The strength of the magnetic fields of these three bodies may be expressed approximately by the product of a physical factor, f, into the angular rotation, ω, the square of the radius, r, and the density, D, of the body. If the same formula could be applied to the other planets, Jupiter, for example, would be enveloped by a magnetic field about as strong as that around the sun.

The physical factor, f, may imply new physical properties or changes in the usual laws of electrodynamics, which may possibly be found to hold throughout our universe. But we find that the earth's intensity of magnetization has been diminishing during the past 80 years at the average rate per annum of 1/1,500 part; how much longer this startling rate of diminution will continue we, of course, can not say at present. The more interesting question is, What changes inside or outside the earth can produce such remarkable changes? Certainly the period of rotation, dimensions and density of the earth have not changed sufficiently during the past 80 years to account for the magnetic change. Shall we say our universal physical factor, f, has changed sufficiently in 80 years to be responsible for the corresponding magnetic change? If so, what does that mean? Are the new physical properties, or the changes in well-known physical laws, implied in f, subject to rather rapid changes, and if so, why?

Let us suppose, for example, that in the factor f we have embodied some physical relation upon which both the earth's magnetism and its gravitational force depend. Then, on the basis of the average annual loss in the earth's magnetism, during the past 80 years, 1/1,500 part, we can immediately say that magnetism and gravity are not related to each other as the first power of the factor. For otherwise a change of 1/1,500 part in the earth's magnetism would imply a corresponding change of 1/1,500 part in gravity, a change too large to have escaped detection. On the other hand, magnetism and gravity may be so related that a magnetic change of 1/1,500 part would only imply a change of the square of 1/1,500 part, or about one half of a millionth part in gravity, and this is a quantity which may readily escape detection with our present gravity appliances unless observations with requisite accuracy are made continuously for a number of years at certain standard stations, so as to obtain the accumulative effect.

The examples cited may suffice to show what importance investigations relating to the earth's magnetism and electricity may assume in our studies of the properties of matter.

A theory which is at present receiving careful examination starts with the possibility that there may be motion of electricity, for example, relative to the mass or volume elements. The rate of motion may differ by a very small fraction from that of the angular rotation of the earth and the paths of the comparatively slowly moving electric particles may be subject to a deflecting effect during the earth's rotation, just as are winds blowing over its surface. The net result of the earth's deflecting effect on these "currents" may be such as to cause, on the average, a slow westerly movement of this system of currents, which in turn gives rise to an induced or demagnetizing field, superposed on the primary field. If such currents are the cause of the earth's internal magnetic field, then their distribution at any given time appears to be largely dependent upon the distribution of land and water, doubtless chiefly because of the difference in electric conductivity of the two bodies. While the results of such a theory would in general agree with the observed facts, it will have to be subjected to further careful investigation before any definite statement may safely be made.

As a resultant effect of all systems causing the secular variation of the earth's magnetism, the north end of the magnetic axis of the internal system of the earth's magnetic field, during the past 80 years, has been moving slowly towards the west, and apparently at the same time slowly towards the equator. The indications are that if the magnetic axis completely revolves around the axis of rotation, the period would not be a few hundred years, but many thousand years. The secular variation thus results from changes, with lapse of time, both in the direction of magnetization and in the intensity of magnetization.

A suggestive effect, dependent apparently upon the distribution of land and water, has been disclosed, namely, that the average equivalent intensity of magnetization, for corresponding parallels north and south, is generally larger for the land-predominating parallel than for the ocean-predominating parallel.

For the earth's internal uniform magnetic field, the following data apply for 1922: The magnetic moment, M, is 8.04×10^{25} C. G. S.;[2] the components of M, respectively parallel and perpendicular to the earth's axis of rotation, are $M_p = 7.88 \times 10^{25}$ C. G. S., and $M_e = 1.60 \times 10^{25}$ C. G. S.; $M_p = 4.93\ M_e$. Were the earth's magnetism uniformly distributed throughout the earth, as it probably is not, the average intensity of magnetization would be 0.074 C. G. S. The magnetic axis intersects the North Hemisphere in

[2] The value of the magnetic moment frequently found in text-books, as dependent on Gauss's analysis for 1830, is 8.55×10^{25} C. G. S. The average annual rate of loss between 1830 and 1922 is about 1/1,500 part, thus corresponding with the annual average rate as given above.

latitude 78° 32′ north and longitude 69° 08′ west of Greenwich.

For fuller details the interested reader may be referred to the issues of *Terrestrial Magnetism and Atmospheric Electricity* for March–June and September, 1923.

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ALICE C. FLETCHER

IN the year 1881 there appeared on the Omaha reservation, in Nebraska, a white woman. She visited the Indians in their homes and began to make friends with them. At first they were not disposed to talk, but after a time it occurred to one to ask: "Why are you here?" She replied: "I came to learn, if you will let me, something about your tribal organization, social customs, tribal rites, traditions and songs. Also to see if I can help you in any way."

At the suggestion of help the faces of the Indians brightened with hope. The Indian continued: "You have come at a time when we are in distress. We have learned that the 'land paper' given us by the Great Father does not make us secure in our homes; that we could be ousted and driven to the Indian Territory as the Poncas were. We want a 'strong paper.' We are told that we can get one through an act of Congress. Can you help us?"

The little woman replied: "Bring me your 'land paper' and come prepared to tell me about your home and the size of the land you have in cultivation. Come soon." The news spread and the Indians came. Each one uttered the oft repeated cry: "I want a 'strong paper' which will make my home secure, so I can work without fear of being ousted." For days the little friend worked hard writing each man's story of his struggle to live by cultivating the soil. This part of the work being done, she then took up the hardest task, that of framing a petition to be signed by the Indians and sent to Congress, which was something new in her experience.

Here was a woman with a courageous heart, full of true sympathy for humankind, sympathy which found expression, not in well phrased words, but in well planned action. This brave, unselfish woman was Alice C. Fletcher, whom the Omahas learned to love.

The petition was signed and on December 31, 1881, sent to Senator Morgan of Alabama. On January 12, 1882, he wrote that on the 11th he presented the petition and it was recorded. Later a bill was introduced in the Senate for allotting lands to the Omahas and for the issuance of trust patents to them. Miss Fletcher came to Washington to help push the bill through. It passed both houses, was approved August 7, 1882, and became law.

In April, 1883, Miss Fletcher was appointed special agent to carry out the provisions of the law. When she was about to begin her work the older members of the tribe came together for consultation as to how they could best express their gratitude for what she had done for the tribe. They decided to perform for her the ancient calumet ceremony, although it was not customary to give it informally. A notice was given to the people to come, and on the day appointed many came and assembled in an earth lodge. The calumets were set up in their sacred place, and when Miss Fletcher entered as the honored guest the house became silent. Three men arose and took up the symbolic pipes (the calumets) and the lynx skin on which they rested; then, standing side by side, they sang softly the opening song. At the close the three men turned, and facing the people, who sat in a wide circle, sang a joyful song as they moved around the circle, waving the sacred pipes over their heads. Song after song they sang for their friend, of the joy and happiness that would follow when men learned to live together in peace. When the evening was over they told Miss Fletcher that she was free to study this or any other of their tribal rites.

Miss Fletcher carried on her ethnological researches among the Omaha, Pawnee, Winnebago, Sioux, Nez Perce and other tribes. She published many papers descriptive of the life and ceremonials of the tribes she studied. The most important of these papers are: "The Omaha Tribe," which was published in the Twenty-seventh Annual Report of the Bureau of American Ethnology; "The Hako: A Pawnee Ceremony," which accompanies the Twenty-second Annual Report of the Bureau; and "Indian Story and Song from North America," published by Small Maynard & Company, in 1900. Many of the ceremonial songs collected by Miss Fletcher have been used as themes by American composers, notably by Cadman, Farwell and others. She held the Thaw Fellowship, Peabody Museum, Harvard University, from 1891 to the time of her death, but had been an assistant in the same institution at a still earlier period. She was vice-president of Section H, A. A. A. S., in 1896; president of the Anthropological Society of Washington in 1903; and president of the American Folk-Lore Society in 1905.

This great friend of the Indians was born in Cuba on the 15th day of March, 1838; on the evening of April 6, 1923, she passed away in her home, in Washington, D. C.

FRANCIS LAFLESCHE