flection of 1".9. Of course the detection of such a minute deflection was an extraordinarily difficult matter, so many corrections had to be applied to the original observations; but the names of the men who record the conclusions are such as to inspire confidence. Certainly any effect of refraction seems to be excluded.

It is thus seen that the formulæ deduced by Einstein have been confirmed in a variety of ways and in a most brilliant manner. In connection with these formulæ one question must arise in the minds of everyone: by what process, where in the course of the mathematical development, does the idea of mass reveal itself? It was not in the equations at the beginning and yet here it is at the end. How does it appear? As a matter of fact it is first seen as a constant of integration in the discussion of the problem of the gravitational field due to a single particle; and the identity of this constant with mass is proved when one compares Einstein's formulæ with Newton's law which is simply its degenerated form. This mass, though, is the mass of which we become aware through our experiences with weight; and Einstein proceeded to prove that this quantity which entered as a constant of integration in his ideally simple problem also obeyed the laws of conservation of mass and conservation of momentum when he investigated the problems of two and more particles. Therefore Einstein deduced from his study of gravitational fields the well-known properties of matter which form the basis of theoretical mechanics. A further logical consequence of Einstein's development is to show that energy has mass, a concept with which every one nowadays is familiar.

The description of Einstein's method which I have given so far is simply the story of one success after another; and it is certainly fair to ask if we have at last reached finality in our investigation of nature, if we have attained to truth. Are there no outstanding difficulties? Is there no possibility of error? Certainly, not until all the predictions made from Einstein's formulæ have been investigated can much be said; and further, it must be seen whether any other lines of argument will lead to the same conclusions. But without waiting for all this there is at least one difficulty which is apparent at this time. We have discussed the laws of nature as independent in their form of reference axes, a concept which appeals strongly to our philosophy; yet it is not at all clear, at first sight, that we can be justified in our belief. We can not imagine any way by which we can become conscious of the translation of the earth in space; but by means of gyroscopes we can learn a great deal about its rotation on its axis. We could locate the positions of its two poles, and by watching a Foucault pendulum or a gyroscope we can obtain a number which we interpret as the angular velocity of rotation of axes fixed in the earth; angular velocity with reference to what? Where is the fundamental set of axes? This is a real difficulty. It can be surmounted in several ways. Einstein himself has outlined a method which in the end amounts to assuming the existence on the confines of space of vast quantities of matter, a proposition which is not attractive. deSitter has suggested a peculiar quality of the space to which we refer our space-time coordinates. The consequences of this are most interesting, but no decision can as yet be made as to the justification of the hypothesis. In any case we can say that the difficulty raised is not one that destroys the real value of Einstein's work.

In conclusion I wish to emphasize the fact, which should be obvious, that Einstein has not attempted any explanation of gravitation; he has been occupied with the deduction of its laws. These laws, together with those of electromagnetic phenomena, comprise our store of knowledge. There is not the slightest indication of a mechanism, meaning by that a picture in terms of our senses. In fact what we have learned has been to realize that our desire to use such mechanisms is futile.

J. S. AMES
THE JOHNS HOPKINS UNIVERSITY

LEARNED SOCIETIES, OLD AND NEW[1]

IT would tax the younger men of science beyond the compass of their imagination, if

[1] President's address at the fourth meeting of the Annual Conference of Biological Chemists, held

for a moment they should stop other activities in order that they might weigh the magnitude of their indebtedness to the scientific societies of the past. It would reduce them below any level of humility if they compared the service of the contemporary societies with those of their ancestors, from whom they are separated by many centuries.

What a glorious record of devotion, sacrifice, and heroism is the history of the early days of the Accademie del Cimento of Italy, of the Royal Society of England, of the Académie des Sciences of France, of the Scientific Societies of Germany.

Somewhere remote in your memory, vaguely and hazily, perhaps, there still lingers a recollection that the bearers of the illustrious names of Copernicus, Gallileo, Toricelli, nay even of Newton, were viewed by their contemporaries with profound suspicion, as dangerous troublemakers; and if the vocabulary of the sixteenth and seventeenth centuries had been as luxuriant as is ours today, those illustrious men might have been disposed of as Bolsheviki.

In the days when those societies came to life, experimentation was a dangerous business. Scholasticism, philosophy, and all classes of organized society, nobility, gentry, clergy were hostile to experimental science. And in spite of these obstacles the result of the efforts of the great pioneers of the seventeenth and of the early eighteenth centuries were preserved and further developed, and made the foundation of our present civilization. In a great measure the success was attained through the activities of the learned societies of those days.

One is filled with astonishment and admiration reading about the great vision of the founders of those academies. They saw clearly all the needs of the new science and of the new times and they grouped together by joint effort to accomplish what they could not do individually. Indeed, so much were they permeated by their desire to serve science, rather than the individual scientist, that often the personalities of the investigators were completely submerged in that of the institution as a whole. In the Accademia del Cimento, as an instance, all the work was published anonymously in the name of the academy. This is perhaps the most sublime example of self-obliteration in the service of an ideal ever known in the history of science.

This oldest of all European societies more than any other emphasized the preeminence of experiment, of creation of instruments, establishment of standards of measurements, over theory and hypotheses. "Probando et Reprobando" was their motto. And indeed the academicians have discharged their task admirably. The number of instruments they constructed is endless, the scientific facts they discovered still stand among the foundations of our present sciences. And Poggendorf, referring to the Accademia del Cimento, says: "Few bodies have so well fulfilled their aims . . . ," and further, "we stand to-day on their shoulders."

The aims of the Accademia del Cimento were adopted by the younger European Society which later received its charter from Charles II. as the Royal Society of England.

This society furthered all the ambitions of its Italian forerunner and amplified on it by its program of social activities. As the Cimento, the members of this society were encouraged through cooperation to improve the tools of the scientists. Thus their members perfected the telescope, devised a spring for watches, improved the microscope. They were constructing laboratories, organizing collections, and by every means were improving the equipment and facilitating the task of the investigator. In a letter to Boyle, Hooke writes:

> We are now undertaking several good things, such as the collection of a repository, the setting up of a chemical laboratory, a mechanical operatory, an astronomical observatory, and an optic chamber.

The great effort made by the society to furnish the English workers with the in-

in affiliation with the American Biochemical Society, in the lecture room of the department of biochemistry in the medical school of the University of Cincinnati, December 30, 1919.

formation acquired outside of England is demonstrated by the creating of the office of a special secretary whose aim it was to maintain correspondence with the scientific men of other lands, to collect foreign publications, to translate them, etc.

In those days when bringing out a book was quite an enterprise the society often undertook the publication of the important works of its members and of other scientists. Indeed through the activity of the Royal Society the world became acquainted with the work of Newton. Writes Newton to Oldenburg, one of the secretaries of the society:

> At reading your letter I was surprised to see so much care taken about securing an invention to me of which I have hitherto had so little value. And therefore, since the Royal Society is pleased to think it worth patronizing, I must acknowledge it deserves much more of them for that than of me, who, had not the communication of it been desired, might have let it still remain in private as it hath already some years.

Indeed to such an extent was the society concerned with the interests of investigators that Secretary Oldenburg devised a way of securing rights of priority even in unfinished investigations.

The emphasis of the Royal Society on social and practical service is seen from the following lines taken from the writings of Sprot, one of the historians of the Royal Society.

> They have propounded the composing of a catalogue of all trades, works and manufactures, taking notice of all physical receipts or secrets, instruments, tools and engines. . . . They have recommended advancing the manufacture of tapestry, silk making. . . . They have compared soils and clays for making better bricks and tiles. . . . They started the propagation of potatoes and experiments with tobacco oil.

Indeed one could continue for hours if he made it his task to enumerate all the important functions undertaken by the Royal Society of England. The history of the French "Académie des Sciences" is only a repetition with variations of the histories of the two forerunners, and very much the same may be said of the early history of the German learned societies, though they came to life many decades later.

And now let us pass decades and centuries and let us make an attempt to write the current history of our own learned societies. What is their social function? What is their contribution to the end of facilitating the task of individual workers? What initiative do they take in introducing scientific methods in the practical activities of our social life?

I fail to find the data on which to write this current history. True, the high specialization of science of to-day makes modern presentations less comprehensive and less thrilling than in the times of Newton and of Leibnitz. True, all the activities of the old scientific societies have been appropriated by special institutions: the university, the technical institution, the research institution, the government bureaus, by the laboratories in the industries, and true it is that present societies can not resume the activities of the old academies. Should the societies of to-day then hibernate 362 or 363 days a year and awaken only for the remaining two or three days in order that the members may be bored by listening to communications which they comprehend not, nor are desirous to comprehend? No, hibernate they need not unless they choose to do so by preference.

The great emergency of the past war has demonstrated how capable of initiative, of achievement, of inventiveness the modern American scientist is, once his interest is aroused, when he is called to join hands with his fellow workers.

The old problems are gone, but new ones are coming up every day. Ours is a large country with great natural resources. It is customary to refer to them as endless. The word is a misnomer, an invention of those in whose interest it is to use the resources recklessly. Human energy is needed to exploit these resources; and human energy is not boundless. Who shall devise methods to preserve our natural resources from devastation? Why not a scientific body, and particularly one composed of biochemists? Nearly two years ago the American Chemical Society

initiated a campaign for the establishment of a research institute of chemotherapy. For the last year the propaganda has painlessly died. Why this lack of perseverance? I can see the need of another institute which would embrace the study of all the materials employed in the industries engaged in the manufacture of agricultural and natural products. True, the industries have undertaken a considerable share of this work, but industries work for the profit of to-day and not for the preservation of national wealth of the future.

Referring again to the biological chemist who interests us particularly, I see his need for better laboratories, of better methods, of better standards; I see the needs that have been pointed out by several members of this conference, and which are placed on the program for discussion, and of a great many more needs. Surely the biological chemist is not the most favored son of society, of the university, or of the medical school.

I am glad that Dr. Gies brought you all together[2] and gave you the opportunity to inaugurate a new type of society, the aim of which is to enhance the social usefulness of the biological chemist, on the one hand, and, on the other, to improve his facilities for work, whether his work be teaching or investigating. Will this new society live to record important service, or will it vegetate a pale, colorless existence? This will depend on the spirit in which you join it. The prospect for service is before you. Once more I wish to compliment Dr. Gies on his vision.

P. A. Levene
The Rockefeller Institute for Medical Research

A BUST OF THE LATE PROFESSOR E. D. COPE

A bust in plaster of the late Edward Drinker Cope, who, at the time of his death in Philadelphia, on April 12, 1897, was professor of zoology and comparative anatomy in the University of Pennsylvania, has been purchased by the subscriptions of some twenty-seven of his former colleagues, associates and students and presented to the zoological laboratory of the university.

This bust is the work of Mr. Eugene Castello, of Philadelphia, and is the one represented in half tone in the number of *The American Naturalist* for May, 1897. Mr. Castello writes:

I had been engaged on portrait busts, of Dr. Matthew Woods, president of the Browning Society, and of Dr. William Mountain, author of "Saint Cecilia." The study of individual character in these portraits, followed by the production of a number of heads of racial types: American Indians, Russian moujiks, Arabs and Frenchmen, directed my attention to the very unusual features of Professor Cope's head. That he was quite aware of the interesting subject he was for a sculptor was soon evident, for he humorously described himself as "gimber-jawed," that is, he meant that the lower jaw was slightly undershot, having much the form of a skate runner extending from ear to chin.

In reference to the circumstances connected with the modelling of the bust, now the property of the university, I consulted a diary that I kept at that time and find that he gave me six sittings for it, beginning October 22, 1896, and the last one on January 6, 1897. At the final sitting he expressed himself as satisfied that I had succeeded in obtaining a good likeness. After Professor Cope passed away, his friend, Dr. Persifor Frazer, saw the bust and invited me to place it in the hall of the American Philosophical Society, May 7, 1897, where it remained for some time. Later it was again exposed there on the occasion of the Cope Memorial meeting [November 12, 1897], where it received favorable criticism from Professor Osborn of the American Museum of Natural History, Dr. Minis Hays and others. . . . Dr. Nolan, of the Academy of Natural Sciences, of this city, also has taken occasion to express his appreciation.

The work of constructive modelling of the head was aided to a considerable extent by the sitter himself, who seemed to be familiar with the anatomical points that differentiated it from any others and which attracted my attention when I met him for the first time. Artists delight in individual character, such as was evident in his head, and upon my expression of interest Professor Cope consented to give me some sittings, although suffering at the time with an incurable

[2] An allusion to the fact that the conference was organized at Dr. Gies's suggestion.