found they are not very abundant, and at most localities and horizons they are so scarce as to be wholly negligible. If the fish bones and teeth were destroyed by organic acids, that would have left the scales intact, as actually happened in the Mowry formation. Dr. Macfarlane perhaps also overestimated the abundance of fish remains in the latter formation. True, scattered scales are quite numerous in portions of the formation, but a few fishes would account for a great many of the scattered scales. The Pierre formation is yielding petroleum in quantity at many localities, yet fish bones, teeth and scales are very scarce throughout the formation at all the numerous localities I have examined, and there are no extensive fish beds from which one may safely assume that the oil has migrated. Many such examples may be enumerated, while places where fish remains are abundant in the neighborhood of oil fields have not been found over great areas occupied intermittently by oil fields. On the other hand, some of the oil-bearing formations contain vast quantities of remains of mollusks, diatoms, foraminifers and other organisms that may have stored in the rocks enormous quantities of carbonaceous material, which may be a source of petroleum. In addition, forms of algae and protozoa without durable parts that would be preserved in recognizable condition in the rocks, some of which represent groups that produce numerous generations per annum, may have deposited carbonaceous material equalling or exceeding the bulk of all other organisms. The protoplasm of all these organisms contain the elements entering into the composition of petroleum. I see no *a priori* reason why any or all of them may not have contributed toward the petroleum.

It is impossible to duplicate experimentally all the deep-seated natural conditions within the thick geological formations, such as heat, pressure, chemical associates and more particularly the time factor. Failure to produce petroleum experimentally from any organisms would not prove conclusively that it could not happen or has not happened under natural conditions during a very long lapse of time. Success in such experiments possibly would not conclusively demonstrate that the same thing has happened in nature. If petroleum is of organic origin, as is rather generally believed, experimentation and discussion, in order to command complete respect, must take into consideration all forms of animal and plant life, and especially the microscopic forms so abundant and almost universally distributed in both fresh and marine waters, all composed chiefly of the elements that enter into the composition of petroleum, each individual of many of the species containing a minute globule of oil.

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SCIENTIFIC BOOKS

PHYSICAL THOUGHT

The Development of Physical Thought. By LEONARD LOEB and ARTHUR S. ADAMS. John Wiley and Sons, New York.

ACCORDING to the preface, this book is the outcome of a course of lectures prepared and given at the University of California by the senior author. The notes of these lectures were used and revised by the junior author and are published as a joint production.

There is wide recognition of the difficulty of the graduate student and the younger physicist in coordinating his rather patchy knowledge and in getting a proper perspective of his science. The historical chronological development of a science is perhaps the natural one. Ideas grow. Even the mistakes and false starts are of value. The student who studies the development of ideas, including the errors, is sure to obtain a knowledge of the growth of his science which will be useful in his later specialization and teaching.

A comprehensive knowledge of the growth of physical ideas is also particularly valuable to the teacher who is presenting the science to the beginning student as a cultural subject.

This book should be a help both to the student and to the teacher of physics, and the reviewer recommends it to their attention. The first chapter, which is headed "Historical," gives an interesting account of the thought and activities of the early Greeks and Romans and the limitations of their scientific methods. The importance of Aristotle and his great influence on thought through the Middle Ages is discussed and stressed. Also the authors point out the great influence of economic and political conditions on the growth of science.

The succeeding chapters take up successively the development of mechanics and dynamics, heat and the structure of matter, electricity and magnetism, light, and finally the electrical structure of matter and the new physics. The space given to each of these topics varies considerably, perhaps according to the special interest of the authors. The chapter on light might have been more extensive and clearer, particularly in the treatment of refraction and dispersion. The last chapter on the new physics is much the longest. This is not so desirable, as the young physicist is apt to know this field fairly well. A philosophical grasp of the growth of classical physics is more important for him and also more difficult.

Just because this is a book that may be largely used by the student of physics it is the duty of the reviewer to point out a few things that are not clear or that may be in error. The treatment of certain topics of the relativity theory is not clear and might be improved. The attempted explanation of the bending of a ray of light on passing the sun is rather confusing, and the student would have difficulty in grasping its meaning. The reviewer makes this statement with some hesitation, as he recognizes the difficulty of presenting relativity ideas in simple terms.

There appears sometimes to be confusion in the ideas of our younger physicists as to the development of certain concepts and results of the relativity theory. This confusion is somewhat evident in this text. At least there are some statements that are not clear. One might cite as a case in point the discussion of the dependence of mass on velocity. On page 164 the authors say: "Other theories based on the electrodynamics of Maxwell gave a change of mass with velocity when the velocity approached that of light, but the equations derived were not substantiated by the experiments of Bucherer." This is not a proper statement of fact. The Lorentz electron equation,

$$m = \frac{m_0}{\sqrt{1-\beta^2}}, \text{ where } \beta = \frac{v}{c},$$

was derived on the classical theory assuming a fixed ether. (See theory of electrons by Lorentz, Columbia University Lectures, 1906.) Historically, the matter is of some interest. Independently of the relativity theory not only was the above equation derived by Lorentz, but Bucherer himself derived a classical expression for the variation of mass, namely

$$m = \frac{m_0}{(1-\beta^2)^{1/3}}.$$

These were both deformable electrons postulated on a fixed ether. The experiments of Bucherer were undertaken to find out whether either of these expressions (or the earlier one of Abraham) was the correct one. His results indicated that the Lorentz equation represented the facts better than his own or Abraham's. One infers from the text, although the statement is not specifically made, that these experiments are a proof of the special relativity theory. However, the experiments of Bucherer could not and did not distinguish between the hypotheses assumed by Lorentz and Einstein. The writer of this review is a proponent of the relativity theory, but he would like to point out that *logically* the experiments of Bucherer are not a *unique* proof of the special relativity theory. They only prove the validity of the equation

$$m = \frac{m_0}{\sqrt{1-\beta^2}}.$$

Another unclear passage is the discussion of the residual advance of the perihelion of Mercury. The authors in discussing the above equation say: "For most earthly motions the relation is such that the mass does not vary appreciably with the velocity, but when v begins to be of same order of magnitude as c, it is seen $(1 - v^2/c^2)$ becomes less than 1 and the mass will increase. A case in point is the variation of the velocity of Mercury in its orbit, which becomes sufficiently great that the mass of the planet computed on the Newtonian basis is no longer able to account for its motion, hence the discrepancy in the calculation of the motion of the perihelion of Mercury mentioned above." This is not very clear, but it seems to mean that the advance of the perihelion of Mercury arises from a change of mass with velocity. This, however, is not the case.

In an elliptical orbit according to the Newtonian Law there is a relation

$$F/m = a$$

the acceleration for each point of the orbit. As the velocity changes in the orbit the mass will change also to a value m'. But according to the general relativity theory gravitational force and mass are proportional. The force F will change also to a value F' in such way that

$$F'/m' = a$$

the same acceleration as before. The ratio of the new force to the new mass will be the same as in Newtonian motion. The residual advance of the perihelion of Mercury arises from a modification of the space due to the sun's gravitational potential. The case is quite otherwise with the motion of an electron in an elliptical orbit about a central charge. Here the mass changes with the velocity, but the force does not. The advance of the perihelion in the case of the electron is described by the *special* relativity theory (or Lorentz equally well). The advance in the case of the planet Mercury is described by the *general* relativity theory.

The reviewer found the chapter headed "Historical" quite interesting. It should stimulate the student to further reading in the history of science.

It is desirable to point out one or two errors of date for future correction. Carthage was destroyed at the end of the Third Punic War 146 B.C. and not 201 B.C., as stated in the text. Also the authors state that "the fakir and simpleton" Cagliostro was put to death by the inquisition in 1750. Cagliostro was born in 1743 and died in prison in Rome in 1795. He can not properly be called a "simpleton." He was rather a very clever and unscrupulous charlatan.

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