(3) I believe it is unwise to attempt the absolute extermination of any native vertebrate species whatsoever. At the same time, it *is* perfectly proper to reduce or destroy any species in a given neighborhood where sound investigation shows it to be positively hurtful to the majority of interests. For example, coyotes, many rodents, jays, crows, magpies, house wrens, the screech owl and certain hawks may best be put under the ban locally.

(4) I believe it is wrong to permit the general public to shoot crows or any other presumably injurious animals during the breeding season of our desirable species. It is dangerous to invite broadcast shooting of any so-called vermin during the regular closed season, when the successful reproduction of our valuable species is of primary importance and is easily interfered with.

(5) I believe in the collecting of specimens of birds and vertebrates generally for educational and scientific purposes. The collector has no less right to kill non-game birds and mammals, in such places where he can do so consistently with other interests, than the sportsman has right to kill "game" species. A bird killed, but preserved as a study-specimen, is of service far longer than the bird that is shot just for sport or for food.

(6) I believe that it is wrong and even dangerous to introduce (that is, turn loose in the wild) alien species of either game or non-game birds and mammals. There is sound reason for believing that such introduction, if "successful," jeopardizes the continued existence of the native species in our fauna, with which competition is bound to occur.

(7) I believe that the very best known way to "conserve" animal life, in the interests of sportsman, scientist and nature-lover, alike, is to preserve conditions as nearly as possible favorable to our own native species. This can be done by the establishment and maintenance of numerous wild-life refuges, not only as comprised in private and public parks, but in national forests and elsewhere.

(8) In the interests of game and wild life conservation generally, I believe in the wisdom of doing away with grazing by domestic stock, more especially sheep, on the greater part of our national forest territory. A further, and vital, interest bound up in this factor is the conservation of water.

(9) I believe that the administration of our game and wild life resources should be kept as far as possible out of politics. The appertaining problems are essentially biological ones and are fraught with many technical considerations not appreciated or understood by the average politician or sportsman. The resources in question should be handled as a national asset, administered with the advice of scientifically trained experts.

JOSEPH GRINNELL

MUSEUM OF VERTEBRATE ZOOLOGY,
UNIVERSITY OF CALIFORNIA

A WHALE SHARK (RHINEODON) IN THE GULF OF SIAM

IN the early part of the year 1919, a huge shark became wedged in the entrance of a bamboo stake-trap set in water eight to nine fathoms deep off Koh Chik (= Chik Island), on the east side of the Gulf of Siam. The fish remained stuck for seven days, during which time all fishing had to be suspended. It was finally killed with rifle bullets and hauled out of the trap, but the combined efforts of the local fishermen were insufficient to drag it ashore.

The fishermen are quite familiar with sharks, which are caught almost daily in the bamboo traps set in the offshore waters of this section, but none of them had ever before seen or heard of a shark of this size or kind. From the descriptions of its shape, color, mouth and teeth given to me by eye-witnesses, I have no doubt the fish was a *Rhineodon*.

While no measurements of the shark were taken, its actual length was known by its position alongside the leader as it lay wedged in the narrow entrance of the trap. From several independent sources I have learned that the length of the monster was determined by the fishermen to be over 10 *wa*. The *wa* is the Siamese fathom, and originally represented the full stretch of a man's outspread arms; in recent years it has been stabilized and adopted by the royal survey department as the equivalent to two meters. Therefore, whether we regard the *wa* as being the somewhat elastic measure of the Siamese fishermen, with, say, 1.7 to 1.8 meters as an approximate average, or as being a full two meters, it would seem that in the fish in question we have rather more than the maximum length that has heretofore been ascribed to the whale shark.

HUGH M. SMITH

BANGKOK, SIAM,
JULY 8, 1925

SCIENTIFIC BOOKS

A Survey of Physics: A collection of lectures and essays by Max Planck. Translated by R. JONES and D. H. WILLIAMS. E. P. Dutton & Co., New York.

INSTEAD of writing a more or less formal review of this book it seems preferable to set forth its substance in a manner as simple and straightforward as possible so as to give the reader some help towards an understanding of the profound changes which modern researches have brought about in the fundamental ideas and theories of physics; and, of course, in a brief discussion of this subject it is necessary to assume that the reader has considerable knowledge of classical physics and that he knows something of the principle of relativity and a little of the quantum hypothesis.

The first really effective method to be employed in the physics was the method of mechanics. This method was founded by Galileo and Newton, and, as the method was developed and more and more successfully applied, it came more and more to dominate the philosophy of physics, until, about the middle of the nineteenth century, the "mechanical conception," as Planck briefly calls it, was generally believed to be an adequate basis for the analysis of all the phenomena of nature; the "mechanical conception" aimed to explain everything in terms of motion; the "mechanical conception" is the view that all phenomena can be reduced to movements of particles or elements of mass.

The discovery of the principle of the conservation of energy (which was at first thought to be a purely mechanical principle) tended to strengthen the "mechanical conception" and the development of the kinetic theory of gases was looked upon as a sample of the unlimited conquests which the "mechanical conception" was destined to make. The latter part of the nineteenth century was the Golden Age of the "mechanical conception."

An interesting consequence of the complete dominance of the "mechanical conception" in the philosophy of physics during the latter part of the nineteenth century was a reaction against the widespread acceptance as ultimate realities of such mechanical pictures as that afforded by the kinetic theory of gases, and this reaction was most effectively voiced by Ernst Mach. There was no definite experimental knowledge of the atom fifty years ago; the atom was only an idea at that time, and the proud philosophy of the "mechanical conceptionists" drove many physicists back to a notion of reality as old as Greek philosophy; and some philosophers like Ernst Mach placed what seems to us now too great an emphasis on this old point of view, namely, the point of view that nothing is real but our sense perceptions and that all science and all philosophy is an economic adaptation of our ideas to our perceptions, an adaptation growing out of our struggle for existence. This economic point of view can hardly explain a Newton or a Faraday, and Planck points out that it seems to be incompatible with the most important characteristic of the sciences, namely, the progressive attainment of a more and more general and unified point of view, which, while being kept in accord with experiment, becomes more and more nearly independent of the individuality of separate intellects, more and more nearly free from purely human bias, more and more nearly non-anthropomorphic.

Nevertheless the "mechanical conception" was a strong philosophy and under its stimulus important scientific work was done and some results of permanent value obtained. Planck mentions the kinetic theory of gases as one of these valuable results. Indeed the kinetic theory of gases is of very great value, although it is based on postulates which ascribe purely mechanical properties to the atom, whereas we have now renounced the purely mechanical conception of the atom.

The method of mechanics may be said to be still retained in modern physics and to be applicable to everything in nature where irreversible processes do not exist or where irreversible processes are neglected, and the method of mechanics thus widely used can be defined as including everything that conforms to and falls under the principle of least action; but the method of mechanics so defined, which Planck calls the method of dynamics, is by no means the same thing as the "mechanical conception" because in many cases it is independent of any knowledge of or any postulate concerning things or substances or particles which move. In particular it includes in its realm such things as electromagnetic disturbances (light) without requiring the existence of the ether, and it is entirely in accord with the principle of relativity.

It is apparently absurd to speak of a method as a mechanical method or as dynamics (after Planck) when there is no thought of motion of concrete things but at best only motion of energy (as in the case of light); but the method, in its mathematical aspects, in the kind of correlation which it accomplishes and in the kinds of measurements involved in its experimental researches, is the same old method of mechanics.

The reader will be left, as it were, in a mental vacuum by the above reference to the principle of least action as the thing which characterizes the method of mechanics, and it needs to be pointed out that the most advanced students of mathematical physics are but little better off than the reader in this respect, for no one as yet has any intuitive appreciation of the principle of least action nor any conceptual insight into its meaning. The mathematical physicist only knows how to formulate the principle mathematically and how to derive its consequences. The principle of least action applies to all mechanical phenomena, to all electromagnetic phenomena (including light) and to all thermal and chemical phenomena; but it fails in all these fields when there is any irreversible action. Because of this failure of the principle it is better to say that it is useful in correlating mechanical, electromagnetic, thermal and chemical effects when the accompanying irreversible action is negligible. All these effects are highly idealized when irreversible action is ignored because every phenomena in nature is accompanied by some irreversible action, and, of course, irreversible action is very much in evidence in many thermal and chemical phenomena.

Another method in physics, the method of thermodynamics, overlaps the method of mechanics, but goes beyond the method of mechanics inasmuch as it recognizes the existence of irreversible or sweeping processes in nature; but the method of thermodynamics has nothing to do with irreversible or sweeping processes themselves, but only with their results, and indeed with only one result, namely, the increase of entropy.

Another method in physics is the atomic method, or atomics, as it is often called. It is certainly true that atoms themselves are now the objects of observation and measurement in the laboratory, but only when the fourth method, the statistical method, as described below, is used. The great theoretical structure which is called the atomic theory, especially that branch of it which is called statistical mechanics (Gibbs) of which the kinetic theory of gases is a special case, is based even now on postulates; for no one could maintain that our real knowledge of atoms is of the kind that could be used as a foundation for any elaborate mathematical structure. The atomic method is the building up of elaborate pictures or conceptions of physical conditions and things, and its chief function is to make physical conditions and things intelligible or thinkable. The kinetic theory of gases, as it exists in the mind of a physicist, is pretty nearly a working model of a gas, and it enables the physicist to "see" the properties of a gas as effectively or even more effectively than he could see them in an actual working model.

A fourth method in physics is the statistical method. The best examples of the use of this method in the laboratory are, perhaps, Perrin's experimental studies of the Brownian motion and Rutherford's experimental studies of the scattering of alpha and beta rays. The statistical method as used in the kinetic theory of gases and in statistical mechanics is a purely theoretical structure and it belongs to the atomic theory, whereas by "the" statistical method we mean the laboratory study of actual erratic things and the interpretation of the observed results by the use of the theory of probability.

The characterization of physics in terms of methods seems to be more significant than the older subdivision of physics into branches according to subject-matter. Thus mechanics, hydrostatics, hydraulics, heat, optics, acoustics, electricity and magnetism are the old branches of physics, and the boundaries between these branches are rapidly disappearing with the advancement of physics, in fact, chemistry can no longer be thought of as a distinct branch of physical science. The branches of physical science grow less and less distinct as physical science develops, but the methods as above enumerated and briefly described are being more and more clearly recognized as distinct methods; and, what is even more important, every one of these methods has been more and more strengthened (in the field to which the method is really applicable) by modern discoveries. Thus Maxwell's theory has very greatly strengthened the dynamic method in the study of light although the electromagnetic theory of light is not a mechanical or dynamic theory in the older narrow meaning of these terms, and the altered points of view which have come from the principle of relativity have strengthened the method of dynamics.

Profound changes in our so-called fundamental ideas in physics have come about in recent years because of two things, namely, (a) an increasingly clear appreciation of the significance of irreversible actions in nature has led us to recognize definite limitations to the method of mechanics (Planck's dynamics), for an irreversible process is beyond the range of the mechanical method, and (b) the principle of relativity has modified our ideas of time and space and has extended the idea of energy to include the idea of mass; but these changes in our so-called fundamental ideas seem to be merely formal or at most these changes seem to have eliminated only what is non-essential from our fundamental ideas, leaving our methods essentially unaltered; but the quantum hypothesis seems to strike more deeply.

The quantum hypothesis denies the principle of continuity as used throughout the method of mechanics. Atomic processes take place by jumps so that the idea of time as a continuous flux is brought into question, and if time as a continuous flux is objectively non-existent then the whole structure of theoretical dynamics must be purely idealistic and at best only applicable to large scale phenomena. Indeed, the atomic theory itself raises the presumption that continuous space is an idea, not a physical fact, as was pointed out by Riemann many years ago, and thus the purely idealistic character of theoretical dynamics is again indicated.

The whole of statistical mechanics, which includes the kinetic theory of gases, is a theoretical structure based upon purely mechanical postulates concerning atomic action whereas the quantum hypothesis rules out the purely mechanical conceptions of atomic action and it seems therefore that the quantum hypothesis is likely to lead to profound changes in the atomic method.

As stated above the methods of physics have remained almost wholly unchanged by modern developments, and, although the principle of continuity is in danger of being thrown out by the quantum hypothesis, the other principles of physics seem to be altered by being made more general. (a) The principle of the conservation of energy still stands, but the principle of the conservation of man has become a part of it. (b) The principle of the conservation of momentum retains its validity in a decidedly widened field. (c) The second law of thermodynamics is untouched. Many men who hold a principle narrowly seem to feel that the principle is destroyed by a change which on careful scrutiny turns out to be only a generalization of the principle.

WM. S. FRANKLIN
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SPECIAL ARTICLES

HIGH VOLTAGE CATHODE RAYS OUTSIDE THE GENERATING TUBE[1]

LENARD succeeded in getting electrons from a cathode-ray tube out through a thin metal window into the air. The voltage employed was that necessary to produce a 3 cm. spark between small spheres. The window consisted of a piece of aluminum foil 0.00265 mm. thick and 1.7 mm. in diameter.

With a specially designed hot cathode, high vacuum tube, it has been found possible to operate with as much as 200,000 volts and several milliamperes, using a window as large as 8 cm. in diameter. The general design of this tube would seem to permit of the use of still larger windows and higher currents.

The maximum range of the electrons in the air in front of the window has been measured approximately by the luminescence of lime. It is a linear function of the voltage applied to the tube and for an aluminum window 0.0254 mm. thick, is given by the equation:

Range (cm.) $= 0.254 \times$ Kilovolts (max.) $- 17.8$. The lowest peak voltage at which there is appreciable intensity in front of and close to the window is 70 kilovolts, and the maximum range at the highest voltage used, 250 kilovolts, is 46 cm.

The luminosity of the air in the path of the discharge is very beautiful, especially at the higher voltages, where, due to scattering, the beam is seen to spread out and bend around until it finally extends more than half as far back of the window as it does in front of it. The appearance is then that of a solid ball of purple glow with its center a little front of the window.

Calcite crystals, upon being rayed, fluoresce strongly in the orange and remain highly luminous for several hours after raying. In addition to this they may show bright bluish white scintillations. These have been observed while the crystal is undergoing bombardment and for as long as a minute after raying. By slightly scratching the rayed surface of the crystal with any sharp instrument, the scintillations may be produced for as long as an hour after raying.

The area in the neighborhood of a scintillation loses all of its luminosity as the scintillation takes place and then appears dark against the bright orange background.

Under the microscope the spot where the scintillation took place is marked by a little crater with many tiny canals leading into it.

The high voltage electrons from this tube when brought into gases cause various reactions somewhat as Lind finds for radium emanation. The quantity relations are such that large amounts of the resulting substances may be made. For example, with such a tube there has been produced from acetylene relatively large quantities (grams) of a yellow compound which resembles the product previously obtained in small quantities both from the corona discharge in acetylene and from the use of radium emanation.

Many liquids and solids also undergo marked chemical changes under the influence of the high speed electrons. For example, castor oil changes rapidly to a solid material. Crystals of cane sugar turn white in color and, upon subsequent gentle heating, evolve considerable quantities of gas. An aqueous solution of cane sugar becomes acid to litmus upon being rayed.

The effect on organized tissues is very pronounced, as may be seen from the following examples.

When a portion of the leaf of the rubber plant (*Ficus Elastica*) is rayed with 1 milliampere for as long as 20 seconds, the rayed area becomes immediately covered with white latex, as though the cell walls had, in some way, been ruptured. An exposure of as little as 0.1 milliampere for 1 second produces a visible color change with subsequent drying out of the

[1] Preliminary communication.