Obituary

Max Planck
1858-1947

Max Planck died in Göttingen on October 4, 1947, shortly before his 90th birthday. By virtue of his introduction of the quantum hypothesis, he was the spiritual father of the modern development of physics and of the basic concepts of many other sciences and their epistomological interpretations.

He was born at Kiel, in north Germany, on April 23, 1858, the son of Wilhelm Planck, a noted jurist like many of his forebears. The family came originally from Schwaben, in south Germany. It was still farther to the south—namely, Munich in Bavaria—that Planck lived during the formative period of his youth. There he went to high school, and there he studied physics at the University. Life in that colorful town with its vigorous tradition in the liberal arts and the humanities greatly influenced his development during adolescence. After his graduation from high school, he wavered between three fields to which he might devote his life: the humanities, music, and physics. Planck gave up the idea of becoming a musician because he decided that his talent was not great enough; still, he was an excellent piano player and often conducted instrumental and vocal concerts in his home with the utmost finesse and deep musical understanding. He decided to become a theoretical physicist. Although keenly interested in the results of experiments, he left the ars experimentandi to others. From the very beginning of his academic career he confined himself to the interpretation rather than the performance of experiments, in spite of the fact that theoretical physics as a separate discipline did not at that time exist in Germany. Decisive for his final choice was the great inspiration he received from the fact that observations in the physical world can be ordered into a logical system. Such laws as the principle of the conservation of energy affected young Planck with the force of a revelation. It is thus understandable that he should have devoted his whole life to studies of the basic laws of nature.

His teachers in physics and mathematics in Munich (1875–77) did not inspire him, but they gave him many facts and interrelations of facts which served as material for Planck's own thoughts and associations. Even a year in Berlin (1878), where Helmholtz and Kirchhoff taught, did not release him from his mental isolation. Helmholtz, whose printed lectures are classics in clarity and beauty of language, must have been a terrible lecturer. He spoke in an inaudible voice, wrote in miniature letters on the blackboard, was unprepared, and often forgot his audience entirely. Kirchhoff, on the other hand, as Planck mentions in his scientific memoirs, gave well-worked-out lectures, but presented them like a memorized script, coldly and impersonally. Planck was therefore forced to base his scientific education on reading of the original literature. He was especially attracted by Rudolf Clausius' writings on thermodynamics, in which this author once and for all disposed of the idea that heat was something analogous to matter. Planck chose for the topic of his doctoral dissertation a thermodynamic subject. He received his degree in Munich in June 1879. There followed several papers on thermodynamics, centering around the concept of entropy—a concept originally introduced by Boltzmann but not applied by him to problems of thermodynamics proper. These papers aroused no interest among the physicists and chemists, just as was the case with similar papers written (prior to Planck's) by Willard Gibbs in this country, but unknown to Planck. When he became acquainted with Gibbs's publications, he acknowledged their priority and more general treatment.

These papers by Planck opened the way to an academic career. In 1880 he became privatdocent in Munich—however, not without clear hints from the famous organic chemist, von Bayer, that Planck's chosen field was a sterile and useless one. Five years later he was elected associate professor of physics at the university in his native town of Kiel. Lack of other suitable candidates apparently played a great role in this relatively quick promotion. Planck indicates modestly in his scientific memoirs that the fact that his father was a close friend of the chairman of the Physics Department in Kiel may have had some influence. Planck's publications during his professorship at Kiel include a book *Über das Wesen der Energie* ("About the Nature of Energy"), which received a prize from the academy in Göttingen, and papers on the increase of entropy in the course of chemical reactions. The latter provoked some controversies with Arrhenius and later with Ostwald. Of course, Planck was right, but it took some time before this was generally acknowledged. The great turning point in Planck's career came in 1889, when he received a call to the University of Berlin to be associate professor. He was promoted to a full professorship in 1892. In Berlin, Planck finally found congenial surroundings which, according to his own opinion, contributed more to the broadening of his scientific understanding than all his previous studies had done. Helmholtz, of course, made the greatest impression upon him. According to his contemporaries, Helmholtz was not only a great scientist whose clarity of mind and penetrating power of judgment everyone admired, but also a human being with a charming personality. However, his human greatness revealed itself only to the few who, like Planck, gained his respect and confidence. For his relations with the hoi polloi, Helmholtz wrapped himself in the robe of dignity becoming to his position as "Wirklicher Geheimer Rat." When Helmholtz became president of the Physikalisch Technische Reichsanstalt, which had just been founded, Kundt became director of the physical institute. His personality and vivid scientific mind attracted Planck very much. The friendship with Heinrich Rubens also started during these years.

After surveying the field of thermodynamics in a book which remained practically unchanged through 9 editions and still serves as one of the principal textbooks of this field in German universities, Planck's interest shifted to the thermodynamics of temperature radiation. It was not just chance that at that time the problem of temperature radiation attracted the minds of the very best physicists everywhere. It is rather one of the most interesting examples proving that pure science is not only the instigator of technological development but often is stimulated by technical progress to solve its most basic questions. Just as the great school of thermodynamics in England originated under the influence of Watt's invention of the steam engine, the pioneer work on temperature radiation can be traced to the inventions which improved the illumination of our houses. This is as true for the pioneer theoretical work of men like Kirchhoff, Rayleigh, Jeans, Boltzmann, Wien, and Planck as for the experimental work of Rubens, Lummer, Pringsheim, and others. The experiments of the last-mentioned group started in the Physikalisch Technische Reichsanstalt, as an attempt to use the black-body radiation for the construction of standards for measurements of illumination intensities.

What was the situation? When the experimentally determined energy of the temperature emission of a black body was plotted against wave length, a curve was obtained with a maximum which shifts toward shorter wave lengths with rising temperature. At infinitely short wave lengths, the intensity goes down to zero and is again low in the region of very long wave lengths. Jeans and Rayleigh, who derived a radiation formula on the basis of the law of equipartition of energy between all degrees of freedom, expected an energy distribution curve of an entirely different character. Their curve is only in agreement with observation in the long wave length region, but has no maximum and deviates grossly in the region of short wave lengths. As a matter of fact, the theory predicted a continuous rise to infinity with declining wave length. Many attempts had been made in vain by the best scientists to overcome this difficulty. W. Wien derived a radiation formula which gave the maximum and was in accordance with observations in the short wave length region. Very careful measurements by Rubens and Pringsheim proved, however, that Wien's law failed to agree with observations in the long wave length region. Rubens kept Planck continually informed about the outcome of the experiments. Planck developed an empirical formula which, for long wave lengths, coincided with that of the Rayleigh-Jeans curve and, for short wave lengths, with Wien's formula. He sent it by postcard to Rubens, and it turned out to fit all observations perfectly. Planck realized that the classical thermodynamics, so very familiar to him, inevitably led to the Rayleigh-Jeans radiation law. Something was apparently fundamentally wrong with the laws of classical physics. One can imagine that that situation became a great challenge to Planck. He worked for months, as he admitted later, more intensely than he had ever worked before or ever would again. His goal was to find out which changes had to be introduced in the assumptions to arrive at a sound derivation of his empirical formula. To his utter astonishment, he found that the theory of the equipartition of energy had to be sacrificed and replaced by the revolutionary assumption that light was emitted and absorbed in energy units—quanta—whose size was proportional to the fundamental constant, h, and to the frequency of the light. He presented this result in a paper read at a meeting of the Berliner Physikalische Gesellschaft on December 14, 1900. This was the natal hour of the quantum theory which, in the course of its development, penetrated into and changed the concepts of practically every field of physics and chemistry; it is still conquering more and more territory in all sciences. It is difficult to say whether the joy of the discoverer prevailed in Planck or the regret that the classical approach to physics, so cherished by him, had failed dismally. He was by his very nature a classicist and by no means a romantic revolutionary. In his derivation of the radiation formula he tried to conserve as much as possible of the classical concept. This very fact introduced a kind of discordance into his theory.

Later (1916), Einstein gave a new derivation of Planck's formula which is now generally accepted. Einstein had no hesitation in going the whole way and removing every part of the classical theory not organically connected with the concept of the quantum theory. Planck, on the contrary, for years made every attempt to reconcile his formula as much as possible with the classical concept. For instance, he was pleased to find that his radiation equation could be derived by introducing the quantum hypothesis for light emission only and not for the absorption process. He did that like a man who, forced by irresistible circumstances to burn the bridges behind him, still casts longing glances toward the territory beyond the river. The writer still remembers vividly a talk which Planck gave at a colloquium in Berlin when the quantum theory was only a few years old (probably 1903). He spoke of some of his attempts to avoid the quantum hypothesis if possible. His conclusions, however, were the following: There is no way out; we have to become accustomed to the quantum theory, and we shall see that it will penetrate into more and more fields of our physics. He was more right than he himself could have anticipated. He could not foresee that our whole concept of the structure of matter would be based on the quantum theory; neither could he have had any presentiment of the future development of quantum mechanics, quantum electrodynamics, etc., which may still have the greatest surprises in store for the physicists.

Planck, who revolutionized science because he had to do so, became a kind of godfather to the second great revolution which shook the fundament of our science during his lifetime—Einstein's theory of relativity. He was one of the very first advocates of Einstein's ideas, and it was he who was responsible for Einstein's coming to Berlin and accepting a position at the Academy there and at the Kaiser-Wilhelm Institute. Planck was fascinated by Einstein's theory in all its phases, and he understood its implications much earlier than most of his contemporaries.

According to his own statement, Planck was especially attracted to the theory of relativity because of its content of absolutivity, meaning the unique position ascribed to the velocity of light. But that remark of Planck's was certainly not meant to be a sufficient explanation of his special interest in the theory of relativity. Revolutionary as it is in its introduction of entirely new concepts of space and time and in the unrelenting strictness with which statements sanctified by tradition were recognized as meaningless and cast away, still the theory of relativity is the keystone, missing for centuries, which perfected the structure of classical physics. That, the writer believes, is the real reason for Planck's strong affection for Einstein's work.

For 40 years Planck remained professor of theoretical physics in Berlin. Generations of physicists followed his lecture courses with enthusiasm because of the clarity and perfection of what he said, and with admiration for the personality of the man who said it.

With advancing age, heavier burdens of an administrative nature were heaped upon him. He felt the obligation to use his reputation for the benefit of science as a whole. He was one of the founders of the Berliner Physikalische Gesellschaft and was most active in the creation of the German Physical Society. He regularly attended the colloquium at the university and was to a great extent responsible for the fact that it was for many years unique, not only in the composition of its audience but in the excellence of the presentations and the breadth of the subjects discussed.

His duties as permanent secretary of the Berliner Academie took another part of his time. In addition, Planck later accepted the presidency of the Kaiser-Wilhelm Gesellschaft. The question arises whether Planck was a good administrator, and the answer depends upon the point of view. If to be a good administrator means to inspire in colleagues and subordinates the utmost confidence in the integrity and justness of their superior, then Planck was undoubtedly a good administrator. His opinions and judgment were often sought in cases not connected with his official duties.

Planck was still president of the Kaiser-Wilhelm Gesellschaft when Hitler rose to power. Certain of his friends and admirers hoped that in the name of science he would raise his voice in open protest against that kind of government and what it stood for. But that did not correspond to his character. The family tradition that the law is sacrosanct was too strong in him. He hated Hitler's laws, but they were the Law and therefore must be obeyed as long as they were in force. However, Planck thought that one could try to influence Hitler, to persuade him to mend his evil ways. He therefore asked for an interview with Hitler. He was courageous enough to say to the almighty dictator what he felt he had to say. He got his interview, but it was doomed to failure. As soon as Hitler found that what Planck wanted, he started a philippic which lasted for hours and which, if not as convincing as Cicero's, at least was delivered with equal power of voice. Planck did not resign from his position. He regarded it as his duty to save what he could of German science during the evil times of the Hitler regime, which he hoped and believed would be only of short duration. The Nazis used

Planck's name to further their own designs by printing a telegram of adulation supposedly sent to Hitler by Planck as president of the Gesellschaft Deutscher Naturforscher und Ärzte. With the newspapers completely under government control, it was impossible for Planck to have a denial printed.

The writer last saw Planck in 1935 on the occasion of a very brief trip from Denmark to Berlin. Planck was extremely unhappy. He responded to the proposal of a visit to Denmark to breathe the air of freedom for a few days in a manner typical of his thinking. He said, "No, I cannot travel abroad. On my previous travels I felt myself to be a representative of German science and was proud of it. Now I would have to hide my face in shame." Still, at that time, Planck did not imagine the total depths of depravity, insanity, and sadism into which Hitler was to lead Germany. He lived to experience it, well informed of what was happening by his second son, Erwin Planck. (His oldest son was killed in action during the first World War.) Erwin Planck, Secretary of State under Schleicher, was a man of the highest courage and integrity and an active foe of the Hitler regime. He later was involved in the unsuccessful plot against Hitler's life and in 1945 suffered a terrible death at the hands of the Gestapo.

When Hitler plunged the world into total war, Planck shared the fate of millions of his countrymen. His beautiful home in Grunewald near Berlin, including his library and all of his personal belongings, was destroyed by bombs. He had to leave Berlin and was trapped for hours in an air-raid shelter in Kassel, which had caved in from a hit. Temporarily he found a home with friends on a big farm near Magdeburg. When the war swept over that area, he and his wife were left shelterless. Finally he was rescued by some American colleagues, members of a scientific mission to Germany, who found him bent in pain from arthritis and brought him to a hospital in Göttingen. Planck's remarkable vitality overcame many of these mental and physical sufferings. It was the execution of his beloved son, Erwin, which finally destroyed his will to live. Although his health improved under the care of his wife in Göttingen, where they now lived in the house of a niece, he was a broken man whose world was shattered. During periods of better health he still felt it his duty to accept invitations for lectures. He used some of his older manuscripts on the relations between science and philosophy which he read to his audience. Death came to him as a redemption. So the life of one of the greatest scientists, upon whom the world had bestowed its highest scientific honors, ended in grief and misery.

May his memory live on in us; he was a great scientist and a man of integrity and justice.

JAMES FRANCK

The University of Chicago

Note: This obituary was presented as a memorial lecture on January 31, 1948, at the meeting of the American Physical Society in New York City, and has been published in the *Year Book* of the American Philosophical Society for 1947, pages 284–292.

NEWS and Notes

Alexander Brunschwig, attending surgeon to the Memorial Hospital for the Treatment of Cancer and Allied Diseases, New York, and professor of clinical surgery at Cornell University Medical College, has been elected to honorary membership in the Vienna Surgical Society. Last year Dr. Brunschwig spent two months in Austria as a member of the Medical Teaching Mission of the Unitarian Service Committee and the WHO Interim Committee, giving lectures and surgical demonstrations in the surgical clinics of Vienna, Graz, and Innsbruck.

W. Ralph Singleton, geneticist at the Connecticut Agricultural Experiment Station, has been appointed senior scientist in the Biology Department of Brookhaven National Laboratory, where he will conduct investigations on the effect of atomic and other types of radiation on plant material. Dr. Singleton, who is widely known for his development of sweet corn hybrid varieties, has been on the staff of the Connecticut Station for 21 years.

W. Taylor Sumerford, professor of chemistry at Louisiana State University, has resigned and on June 1 will take up his new duties with the Technical Development Division, Communicable Disease Center, U. S. Public Health Service, Savannah, Georgia. Dr. Sumerford will be in charge of the Chemical Investigations Branch, which is engaged in research on chemical compounds used in controlling rodent and arthropod vectors and reservoirs of communicable diseases.

Adriance S. Foster, Department of Botany, University of California, has been appointed visiting lecturer in botany at the University of Illinois for the 1948 Summer Session, which extends from June 18 to August 14. Prof. Foster is to offer a course in Plant Anatomy and a seminar in Plant Morphology.

S. P. Swenson, assistant director of the Washington Experiment Stations (Pullman) and head of the Department of Agronomy, is on a four-month trip to Germany as a technical agricultural adviser to the military government. In his absence, **S. C. Vandecaveye,** chairman of the Soils Section, is acting head of the Depart-