Hendrik Anthony Kramers: 1894–1952

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WHEN Hans Kramers died in Leiden on April 24, 1952, after a serious lung operation, the world lost one of its most outstanding theoretical physicists.

Kramers was born in Rotterdam, the Netherlands, on December 17, 1894. He studied at Leiden from 1912 to 1916 under Ehrenfest, who first advised him to become a high school teacher. Kramers' career as a high school teacher in Arnhem lasted about two months; then he went to Copenhagen. In 1919, as a result of his studies under Niels Bohr, he obtained his doctor's degree from Leiden on a thesis "Intensities of Spectral Lines." It was the first successful attempt to calculate these intensities, using Bohr's "principle of correspondence" between classical physics and quantum theory.

Bohr had a great influence on Kramers' outlook on physics and on life in general. In 1920—the year he married the talented Danish concert singer Anna Petersen—Kramers was appointed assistant to Bohr, and in 1922 he became "lector" in theoretical physics at the University of Copenhagen.

In 1926, Kramers returned to the Netherlands to succeed Julius as professor of theoretical physics in Utrecht, and in 1934 he was appointed to the chair of theoretical physics in Leiden, as Ehrenfest's successor. He remained in Leiden until his death, serving also as professor extraordinary at the Technical University of Delft.

Kramers' feeling about his work as a professor of physics can probably best be characterized by the following quotation from his inaugural address at Leiden: "I have not accepted here the position of an incarnated hand- and yearbook, or of an abstracting journal of theoretical physics, but rather the position of a physicist who is going to instruct the youth. . . . It will be my duty to help develop in each student as well as possible a close relationship between him and physics."

Kramers' students can bear witness as to how well he acquitted himself of this duty. His devotion was evident from the way he conducted lectures, colloquia, and oral examinations. The latter, usually lasting several hours, were often as much lectures to the students as examinations of their knowledge. In the student colloquium he used to slow down the speaker by asking for details and for fuller explanations of whatever he thought the students in attendance would find difficult to follow or to understand. Also, in his regular lecture courses, he was always ready to moderate his speed as soon as he observed that some of his students were having difficulties.

Kramers was a brilliant mathematician. Examples of his elegant methods abound in his work, but, characteristically, mathematical details are relegated to small type in his monograph on quantum mechanics. In his preface to this monograph Kramers remarks: "The apparent lack of mathematical conscience, to which the text often guiltily refers, cannot be attributed solely to the limitations of the author; a physical conscience . . . in its purest form—i.e., unimpeded by pedagogical considerations—does not get along easily with its mathematical counterpart within the confines of the human mind (or of a publication)." In his inaugural address at Delft, Kramers told his audience that, "although the forming of ideas is only part of what in general is called theory, for a physicist it is the essential foundation of his theories." From these two quotations we may grasp Kramers' opinion of the position that mathematics should occupy in theoretical physics.

Kramers' interests were universal, and in his scientific works one can find papers in fields as divergent as physiological optics, astrophysics, physical chemistry, the history of science, and the theory of relativity. His main contributions to theoretical physics were in the field of quantum mechanics. As it is impossible to mention all his papers, we shall discuss only a few of the more important ones.

Many of his investigations dealt with the emission and absorption of light by atoms and molecules. Kramers' dispersion theory led to his theory of incoherent scattering of light, which predicted the Raman effect and was used by Heisenberg as one of the steppingstones to his matrix mechanics. In 1926 Kramers developed a method for obtaining an approximate solution of the wave equation for an electron in a central field of force. Wentzel and Brillouin independently had arrived at essentially the same result, and the method is usually called the W.K.B. method after its three originators.

Kramers made important contributions to the theory of the multiplet structure of spectra, and extensive use has been made of his "symbolic method," an ingenious application of the theory of invariants, by which he derived results that are otherwise obtainable only by long calculations using group theory. In 1935 he showed that in a periodic field of force the energy

levels form separated energy bands. Among his many contributions to statistical mechanics are several papers on ferromagnetism and antiferromagnetism, and the paper by him and Wannier on order-disorder in a two-dimensional lattice has greatly stimulated recent developments in this field. In 1934 De Haas, Wiersma, and Kramers reported the attainment of a temperature as low as a few hundredths of a degree absolute by using the Debye-Giauque method of adiabatic demagnetization.

In 1922 Kramers, in collaboration with Holst, wrote a popular book on Bohr's theory, which later was translated from the Danish into English, German, Spanish, and Dutch. In the years 1933–37 he wrote his famous monograph on quantum theory, published in 1938 as Volume 1 of the *Hand- und Jahrbuch der chemischen Physik* and reprinted in America in 1944. Still valuable as a textbook, it contains an original derivation of Dirac's relativistic quantum theory of the spinning electron. The most important part of this volume is its last chapter, where we find the first part of Kramers' nonrelativistic quantum theory of radiation. It is not always realized that the development of quantum electrodynamics through the work of Schwinger and many others is an extension of this theory of Kramers, who presented it in this country in his lecture at the Shelter Island Conference in June 1947.

Kramers was a welcome participant at international conferences. His natural gift for foreign languages enabled him to take part in all that was going on and made him eminently suited to fill the position of chairman, as he did on many occasions. With the greatest ease he would start in one language and then continue immediately in another language, as circumstances dictated.

After World War II Kramers was active in both national and international organizations. In 1946 he was elected chairman of the Scientific and Technological Committee of the United Nations Atomic Energy Commission, and he was able to present to its political committee a unanimous report, which concluded that control of atomic energy is technologically feasible. From 1946 to 1950 he was chairman of the International Union of Pure and Applied Physics. He helped organize the twenty-six international conferences that were held during that period under the auspices of the IUPAP in eleven different countries.

He was the driving force behind the reorganization of physical research in the Netherlands after World War II. Results of this activity are the Foundation for Fundamental Research of Matter (FOM), the Institute for Nuclear Research in Amsterdam, and the Dutch-Norwegian cooperation that led to the Joint Establishment for Nuclear Energy Research in Kjeller (Norway).

Kramers was visiting professor in Ann Arbor in the summers of 1928 and 1938, and in 1930 at the University of California (Berkeley) and at Purdue University. In 1947, he spent most of his time in Princeton, but gave lectures at other American universities. In the fall of 1951 he made his last visit to America. He had to cut short his stay in Princeton to attend the inauguration of the atomic pile in Kjeller.

Kramers received honorary degrees from Oslo, the Sorbonne, Lund, and Stockholm. He was an honorary member of the American Physical Society. He was a member of the academies of sciences of Denmark, the Netherlands, Belgium, France, and Norway, and of the Royal Society of Edinburgh. In 1948 he was awarded the Lorentz Medal and, in 1951, the Hughes Medal of the Royal Society of London for his contributions to the theory of the magnetic properties of matter. He was one of the principal editors of the Dutch encyclopedia *ENSIE* and he was a member of the board of editors of the Dutch journal for religion and culture *Het Kouter*. He was a member of the Dutch Society for Literature.

Kramers loved unconventional spontaneity. Sometimes this revealed itself by an unusual remark, profound or jocular. He often had the sincerity and courage to do or say what other people wished to do or say but did not dare to. He loved his family, his science, his colleagues, his students, his music. He was a gifted cello player and regularly played chamber music with his friends. He lived to the full, and his death has created a void not only in the world of physics, but also in his own circle of close friends.