

Professor of Science. Bean joined GE in 1951, a year before he completed his PhD at the University of Buffalo. He is the director of the Bellevue Research Foundation and president of the board of the Dudley Observatory in Schenectady. In addition he has served as an associate editor of the *Biophysics Journal* and a member of the editorial board of the *Journal of Applied Physics*. In 1983 Bean was appointed Distinguished Research Professor of Science at RPI, a part-time post, but he has since decided to enlarge his teaching and research activities.

Obituaries

Paul P. Ewald

Paul P. Ewald, a key figure in the evolution of modern physics, died at his home in Ithaca, New York, on 22 August 1985, at the age of 97.

Ewald was born in Berlin, Germany, in 1888. His father, who died shortly before Ewald was born, was a historian at the University of Berlin. His mother was an internationally successful portrait painter. He learned to speak English and French before starting school, and his classical education at the *Gymnasium* gave him a lifelong love of literature and languages, especially classical Greek; he readily quoted Homer throughout his life. Soon attracted to the sciences, he tried chemistry at Cambridge, then mathematics at Göttingen and Munich, where he was finally drawn to physics. He thought of Arnold Sommerfeld, David Hilbert and Alfred Pringsheim as his most important teachers. From among the thesis topics proposed to him he chose what Sommerfeld considered the "least promising" one, namely "Dispersion

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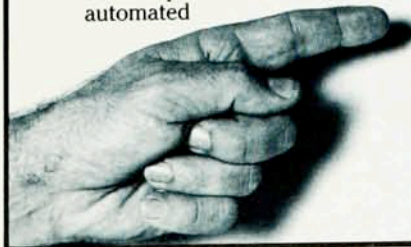


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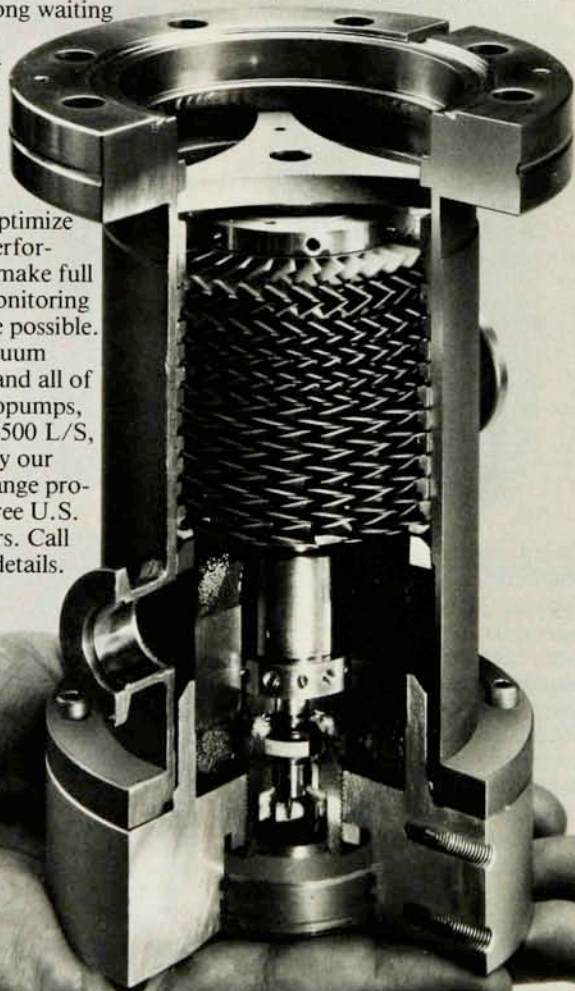
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and double refraction of electron lattices (crystals)." He had been fascinated since boyhood by light and its interaction with solid matter, and he was to be preoccupied by this topic for the rest of his life.

Shortly before submitting the thesis, he sought an interview with Max von Laue to clarify some details. In the course of this discussion Laue conceived the idea of x-ray diffraction in crystals. Experiments quickly established x rays as waves and confirmed the existence of crystal lattices. This concept was basic to Ewald's thesis, which also contained most of the mathematical formalism of the dynamical theory of x-ray diffraction in perfect crystals. The theory was worked out fully shortly thereafter.

During his professorship in theoretical physics at the Technische Hochschule, Stuttgart (1921-37), Ewald's department became an international center for x-ray diffraction and solid-state physics. In 1932 he became *Rektor* (equivalent to university president), but resigned this post soon after the Nazis came to power. He continued in his position as professor until 1937, when he was pensioned after walking out of a faculty meeting in protest over a speaker's statement: "Objectivity is no longer a valid or acceptable concept in science." Soon thereafter he left Germany for Cambridge, England, where he had been offered a small research grant. Subsequently he held academic positions at Queen's University, Belfast, Northern Ireland (1939-49), and the Polytechnic Institute of Brooklyn (now of New York, 1949-59), where as department head for seven years, he created a new center for research. Retirement in 1959 did not stop his research nor his many other endeavors relating to crystallography.

Ewald's celebrated theory of x-ray diffraction (1917) remains a masterpiece of a self-consistent theory of normal modes including many-body interactions, and its treatment of optical boundary conditions at the microscopic level (the extinction theorem) is unsurpassed.

Forty years passed before the semiconductor industry produced crystals of sufficient perfection to permit detailed confirmation of the theoretical predictions. Today, this same theory enables industry to verify the vitally important perfection of its crystals, and in such applications as x-ray interferometry, leads to precise values for many solid-state parameters. The theory's influence, however, extends beyond x rays: The original theory of electron diffraction in crystals (by Hans Bethe) drew on Ewald's concepts, and its subsequent development as a quantitative tool was essentially dynamical. It may be surprising to learn that even

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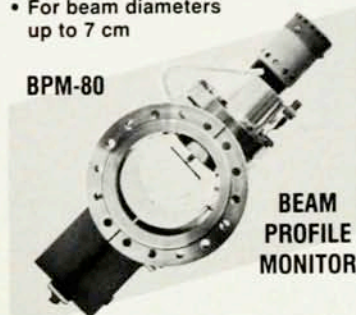
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the analysis of many of the contrast details in the electron microscope, which are generated by strain fields of dislocations, relies heavily on Ewald's conceptual description of two-beam dynamical interactions, including anomalous absorption (the Borrmann effect). An offshoot, the Ewald sum procedure, was originally invented to calculate the electrostatic energy of an ionic crystal and is widely used, for instance, in modern band-structure calculations.

For 60 years Ewald was a prime mover in x-ray crystallography. His book *Kristalle und Röntgenstrahlen* (1923) gave the first comprehensive treatment of the subject, while *Fifty Years of X-Ray Diffraction* (1962) surveyed the mature field. Together with C. Hermann he founded *Strukturbericht* (first published in 1931), a collection of results on crystal structures, which, with its successor volumes *Structure Reports*, is the standard structure-data repository for industry and science. The *International Tables*, also conceived by him in the 1930s, set the uniform nomenclature, units and standards for the specification of these data. After World War II, Ewald initiated *Acta Crystallographica* and acted as one of its chief editors from 1948 to 1959. He was president of the American Crystallographic Association for 1951-52.

Ewald was very much concerned with the international character of his science. After World War II he was instrumental in reestablishing the International Union of Pure and Applied Physics, serving as its first secretary-general and later as vice-president. He was instrumental in founding a separate International Union of Crystallography, of which he served as president for some time.

The success of these diverse and wide-ranging science-policy initiatives rested largely on Ewald's personal qualities as a scientist of high vision and standards and as a diplomatic and convincing negotiator, but ultimately on his disarming honesty and modesty. To his students and colleagues he was not only a window into the larger world of science and the intellect, but also a model physicist in his scrupulous search for the physically correct and lucid formulation of ideas. He was equally demanding in his insistence, honed by long years as an editor, on the precise language in which these ideas were to be expressed. At the same time, he always enjoyed his science and was delighted when progress was made, either by himself or by others. He remained receptive to new ways of thinking and was ready to get them a fair hearing when normal processes for doing so broke down. Finally, there is no better testimony to his personal

qualities—harmoniously complemented by those of his wife, Ella—than their enormous international circle of friends, who made the Ewald residence, wherever it was, an eagerly sought-out stopover point for travelers from far and wide.

In 1979 Ewald received the first Gregori Aminoff Medal of the Royal Swedish Academy, in honor of his lifelong accomplishments. In 1985 IUC established the Ewald Prize, which will be awarded for the first time in 1987 (see page 81).

In his late eighties, Ewald told one of us that he would like to "finish his doctor's thesis" by finding a way to deduce the structure of a crystal directly from the intensities of the x-ray diffraction spots. He would have been delighted that the 1985 Nobel Prize in chemistry was awarded to Jerome Karle and Herbert Hauptman for finding a solution to this problem.

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Maurice A. Biot

Maurice A. Biot died peacefully at his home in Brussels on 12 September 1985. Biot was born in Belgium in 1905, and obtained degrees in electrical engineering, mining engineering and philosophy as well as a DSc (1931) at the University of Louvain. At Caltech, where he received a PhD in aeronautical sciences (1932), he was first a student and then a collaborator of Theodore von Kármán, with whom he wrote a classic textbook, *Mathematical Methods in Engineering*. He taught at Louvain, Harvard and Columbia. At the outbreak of World War II he enlisted in the US Navy, for which he did work on the theory of explosions and armor penetration. After the war he was briefly on the faculty of Brown University.

The largest and probably most significant portion of Biot's research dates from the years after 1950, when he became an independent consultant and worked for Shell Development, Cornell Aeronautical Labs, sundry government agencies and, most recently, Mobil Oil. He was elected to the US Academy of Engineering and the Royal Academy of Sciences of Belgium, and held several