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Robert V. Langmuir

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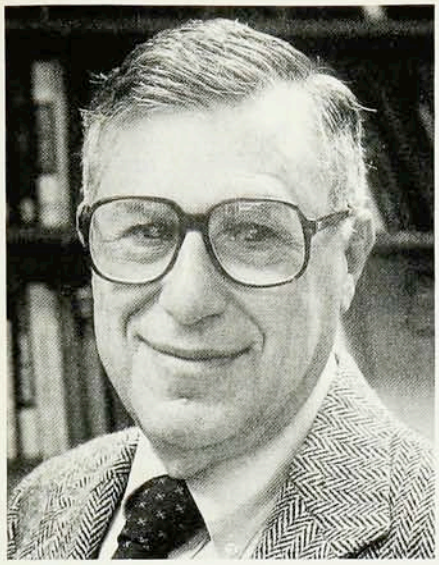

Herbert B. Callen

Callen spent a year at the MIT Laboratory for Insulation Research, where he developed the theory of electrical breakdown in insulators.

In 1946 Callen received an appointment as an assistant professor in the physics department of the University of Pennsylvania, where, with Theodore A. Welton, he derived the fluctuation–dissipation theorem. This universal theorem, which contained within it Nyquist's theorem of resistance and voltage fluctuations, demonstrated from first principles the equivalence of the linear response of a driven thermodynamic system to the time-dependent equilibrium fluctuation of the system. This work, published in 1951, launched the statistical theory of irreversible processes.

Callen's later research focused on magnetism; he was a pioneer in the use of thermodynamic Green's functions in magnetism. He and his students formulated a many-body theory for spin operators, analogous to fermion- and boson-based many-body theory. They also developed useful approximation methods similar to the random-phase approximation of fermion and boson systems.

Callen delighted in finding interesting physics in the development and improvement of devices, especially those in which magnetism played a role. He assisted J. Presper Eckert and John W. Mauchly, the developers of the Univac computer, in setting up a research group at Univac in Bluebell, Pennsylvania, that concentrated on magnetic effects in solids with the goal of inventing more cost-effective fast computer memory.

Callen's text *Thermodynamics* (Wiley, 1960) is based on the postulatory formulation of thermodynamics in which state functions, energy and entropy are the fundamental concepts; processes enter simply as differentials of the state functions. The second, much revised edition *Thermodynamics and an Introduction to Thermostatistics* (1985) is among the most frequently cited thermodynamics references in the physics research literature.

Callen's teaching at both undergraduate and graduate levels was renowned for its intellectual integrity and clarity of presentation. One of his great strengths was the development of simple "hand waving" arguments to explain seemingly complicated phenomena. He was a strong unifying force within the University of Pennsylvania physics department and was instrumental in recruiting key solid-state physicists to the university in the late 1950s. He played an active role in academic affairs at the university until he retired in 1985. Callen was active on a number of committees for the American Physical Society, IUPAP and the National Magnet Laboratory. He also was a visiting professor at the Hebrew University in Jerusalem, at the Weizmann Institute of Science in Rehovoth, Israel, and at the University of Recife, Brazil.

Herb was a deep and incisive thinker, always rational and with endless intellectual curiosity. He had a mischievous and energetic zest for life and was skeptical of dogma and authority. He was modest about his own scientific accomplishments and was always supportive of his colleagues. He leaves behind a rich intellectual legacy.

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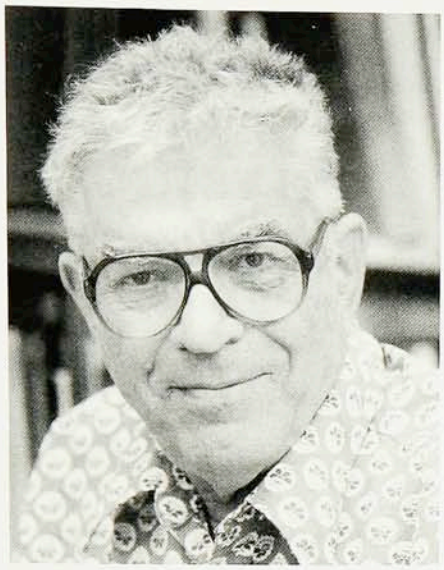
Robert V. Langmuir

Robert V. Langmuir, professor emeritus of electrical engineering at Caltech and a member of the team that first directly observed synchrotron radiation, died of cancer on 7 May 1992, at the age of 80. Langmuir had had a long and productive career as an educator, physicist, engineer and inventor.

After graduating with an AB in physics from Harvard in 1935, Langmuir designed mass spectrometers at the Consolidated Engineering Corporation in Pasadena, California. Subsequently, for his doctoral thesis in physics at Caltech in 1943, he improved the stability and image quality of electron microscopes. During the



Robert V. Langmuir

World War II years, Langmuir worked at the General Electric Research Laboratory in Schenectady, New York, on high-powered continuous-wave magnetrons for jamming enemy radar.

At the end of the war Langmuir joined a group at GE that developed a 70-MeV electron synchrotron. In 1947 Langmuir, Frank Elder, Anatole Gurewitsch and Herbert Pollock reported the first observation of visible radiation emitted tangentially from the electron orbits in this synchrotron. The group recognized the source of the radiation almost immediately, and quickly verified the electron-energy dependence of the spectrum and intensity of the radiation. Now known as synchrotron radiation, it plays an important role in astrophysics and has become a powerful tool in condensed matter physics. Langmuir also demonstrated with the 70-MeV synchrotron the effectiveness of photonuclear reactions in producing new radioactive nuclei; this work led to his discovery of the nuclide ^{37}K.

In 1948 Langmuir returned to Caltech, where he collaborated with Robert Bacher, Robert Christy, Robert Walker, Matthew Sands and Alvin Tollestrup in the design and construction of a 550-MeV electron synchrotron. With this felicitous choice of energy, the new accelerator was able to demonstrate for the first time the profile of the now well-known $J = 3/2$, $I = 3/2$ nucleon resonance. Langmuir focused his own continuing research on developing the much-higher-powered radiofrequency systems that would be needed to reach higher energies—systems that could overcome the prodigious radiation losses and the instabilities arising from radiation quantum fluctuations. Eventually the accelerator was pushed to 1.5 GeV.

During this period Langmuir also collaborated with colleagues at the Ramo–Wooldridge Research Laboratories in Los Angeles on the development of an electrostatic micrometeoroid accelerator for space research and on the containment of charged particles by electromagnetic multipole fields. In 1959 Langmuir, Ralph Wuerker and Haywood Shelton reported the first three-dimensional electromagnetic containment of micron-sized dust, iron and aluminum particles. An unanticipated feature of this pioneering study was that Langmuir and his colleagues were able repeatedly to "freeze" the particles into a stable lattice and then "melt" the lattice, without losing containment, by raising and lowering the field strength.

At Caltech, in addition to teaching, Langmuir served as executive officer for electrical engineering from 1960 to 1970. His favorite courses were electronics and classical electricity and magnetism. In 1960 he wrote a concise and very useful textbook, *Electromagnetic Fields and Waves* (McGraw–Hill), based on one of his courses.

Langmuir's students recall his emphasis on fundamental principles and his insistence that they present their work clearly and logically. He was a kind and warm colleague, who liked most of all to add to his friends' enjoyment of life by loaning them records from his excellent library of classical music.

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Joseph Valasek

Joseph Valasek, an emeritus professor of physics at the University of Minnesota, died on 4 October 1993 in Minneapolis, at the age of 96. Valasek was the discoverer of ferroelectricity, which he identified in Rochelle salt in the 1920s.

Ferroelectricity is of great scientific interest and is very important in technology. Valasek was the first person to recognize the nature of ferroelectricity and its principal characteristics, such as the phase transformation, or Curie point, the reversible polarization and the domain structure. He essentially characterized the behavior completely, even though the effects were known only in one specific material at the time.

The generality of his discovery was not appreciated until long after Valasek had left the field. In many ways Valasek was ahead of his time. Physics in the 1920s was correctly preoccupied with the quantum revolution; solid-state physics was not a popular field. Phase transitions and cooperative phenomena, of which ferroelectricity is a major example, really flowered only after the mid-1950s. Furthermore, Rochelle salt remained a unique example of ferroelectricity for many years. In today's age of "relevance," Valasek's work illustrates dramatically the long-range importance of basic research in providing the foundation for tomorrow's technology.

Valasek was born on 27 April 1897, in Cleveland, Ohio. He received a BS in physics from Case Institute of Technology in 1917. After this he worked for two years at the National Bureau of Standards before starting his graduate studies at Minnesota. After receiving his physics PhD in 1921, he spent another year there as a National Research Council fellow. In 1922 he was appointed to the Minnesota faculty as an assistant professor. He was promoted to associate professor in 1927 and to full professor in 1941.

After his pioneering work on ferroelectricity, pursued at Minnesota, Valasek spent the academic year 1928–29 at Manne Siegbahn's laboratory in Uppsala, Sweden, where he began investigating chemical effects in x-ray spectra and their connection with electronic energy bands in solids. This work, which he continued during the 1930s using the relatively primitive equipment of the time, anticipated by 30 to 40 years the serious development of the subject. In addition to research articles, Valasek wrote four review articles and two textbooks on optics: *Elements of Optics* (McGraw–Hill, 1927) and *Introduction to Theoretical and Experimental Optics* (Wiley, 1949). From the 1940s until his retirement in 1965, Valasek devoted his attention almost entirely to teaching. His courses in both theoretical and experimental optics were greatly appreciated.

Because Valasek was a pioneer whose main work was done well before his field became popular, and because he was very quiet and modest and did not seek recognition and honor for his work, he never achieved the recognition he deserved.

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[*Editor's note*: We are sorry to learn that, since writing this obituary, Alfred O. C. Nier has died.] ■