devised circuitry that eliminates mechanical shutters on high-speed movie cameras.

He has made important contributions to deep-sea research, and his methods have been widely adopted by oceanographers. Edgerton has developed special electronic and flash equipment to take underwater pictures and a sonar instrument that determines the distance from a camera to the sea bottom. During recent years he has worked with archaeologists and geologists in Israel and Greece to probe the sea optically for the remains of ancient cities. Among his other innovations are a shutter that uses a light-triggered pulse of current to rotate the plane of polarization in a specially designed glass column, and a technique for photographing shock waves in broad daylight.

## Charles C. Lauritsen Was Nuclear-Research Pioneer

Charles C. Lauritsen, professor emeritus at California Institute of Technology, died on 13 April. Born in Holstebro, Denmark, he attended Odense Tekniske Skole in Denmark, where he received his BS in 1911. He obtained his doctorate at CIT in 1929, a year after becoming a US citizen. At CIT he became an assistant professor of physics in 1930 and was professor since 1935.

During World War II he served as a vice chairman of the National Defense Research Council, a director of research for the Office of Scientific Research and Development and was on numerous other committees. In close association with Robert Dexter Conrad, USN, Lauritsen helped to establish the Office of Naval Research in 1946, and in 1958 he was the second recipient of the Conrad Award for his scientific contributions to the Navy. At the time of his death he was a member of the President's Scientific Advisory Committee.

Lauritsen was a fellow of the American Physical Society (and past president in 1951), the College of Radiology, the Royal Society of Copenhagen and the American Association for the Advancement of Science. He was also a member of the National Academy of Sciences, the American Philosophical Society and Sigma Xi.

Lauritsen's earliest scientific work was a study of electron emission from metals in high electric fields. This work, published with Robert A. Millikan in 1928–29, was directed to a quantitative determination of the dependence of field-emission current on field strength and temperature. The results clearly showed that the Schottky theory was inapplicable to this phenomenon and provided one of the first experimental demonstrations of the wave-mechanical theory of barrier penetration.

In 1928 he undertook the construction of a high-voltage x-ray tube that operated at 750 kV. Further developments in this direction led to tubes that operated reliably above $10^6$ V and eventually to the development of the positive-ion accelerating tubes that he used for research in nuclear physics.

In the course of his development of high-voltage x-ray tubes he thought of the possibility that such installations might well prove to be advantageous in the treatment of deep-seated malignant tumors. He succeeded in interesting a group of radiologists in the problem, and after some preliminary clinical experiments in 1930, he established an operating facility—the Kellogg Radiation Laboratory—to carry on an extensive experimental program in deep x-ray therapy. Throughout the duration of the project Lauritsen worked closely with the radiologists by providing technical advice and by devising the needed special instrumentation. He proposed a redefinition of the roentgen unit that extended its usefulness to the high-voltage field and that was subsequently incorporated into the international definition. For his contributions to the understanding of the physical problems of radiology he was elected a fellow of the American College of Radiology in 1931.

LAURITSEN

In 1932–33, immediately after the announcement by John Cockcroft and Ernest Walton of the first successful nuclear transmutation by artificially accelerated particles, Lauritsen converted one of his high-voltage x-ray tubes to a positive-ion accelerator. The following year he and his collaborators reported the first production of neutrons with accelerated helium ions and deuterons, and the first observation of accelerator-produced radioactive substances. Simultaneously with these enterprises he initiated a series of studies of the transmutations of the light nuclei that continued under his direction up until his death.

The principal lines of Lauritsen's work in nuclear physics had been directed largely to the problems of the character of nuclear reactions and the elucidation of the structure of nuclei. Out of this work came the discovery of a number of light radioactive elements, the demonstration of positron-annihilation radiation and the observation of high-energy gamma rays associated with nuclear transmutations. These early experiments also established the relative masses of the light nuclei and revealed the first evidence of the existence of "mirror" nuclei.

At the conclusion of World War II Lauritsen turned his attention to improving the precision of nuclear-reaction research. To this end, he developed a number of instruments and techniques, including an electrostatic analyzer of high precision and a family of magnetic spectrometers that became standard laboratory equipment.

The primary emphasis of his investigations since 1947 had been the precise determination of the energy release in nuclear reactions and the establishment of a consistent and reliable scale of masses for the light nuclei. Concomitant with this endeavor had been the determination of the locations and character of the excited states of these nuclei, a project that has engaged the attention of many laboratories. Although the present highly advanced state of empirical knowledge in this field represents the efforts of many physicists all over the world, Lauritsen's early and continued contributions did much to set the standards and to point the way for further progress. □