the construction of the new ski lodge that now bears his name.

Thorn was an inspirational leader who will be missed by friends and colleagues both in the US and abroad.

JOHN C. HOPKINS
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Albert Rose

Albert Rose, a pioneer in the development of electronic imaging and in the physics of photoconductivity, of electron transport in solids and of human vision, died in Princeton, New Jersey, on 26 July 1990, at the age of 80.

A native of New York City, Al received an AB (1931) and a PhD (1935) in physics, both from Cornell University. Shortly after finishing graduate school, he joined the technical staff at the Radio Corporation of America, where he continued to work until 1975. Upon retiring from RCA, he was appointed Fairchild Distinguished Scholar at Caltech. Later he served as a visiting professor at a number of universities both in the US and abroad, and as a visiting scientist at several industrial labs.

Al Rose has been called the father of electronic imaging because he invented the orthicon and image-orthicon camera tubes and produced landmark papers on the performance limits of electronic imaging devices, the human eye and photographic film. Originally developed for military purposes by Al and two of his colleagues during World War II, the image orthicon served for 20 years as the electronic eye of television. After the war Al led a small group of scientists at RCA Lab in developing the first of the solid-state camera tubes—the photoconductive vidicon, which is still in use today.

Al took a broad view of electronic imaging. When working on the practical development of imaging tubes, he looked into every corner of the fundamental physics of imaging, from the basic mechanisms of photoconductivity to the physics of vision. His early papers on photoconductivity laid the groundwork for the field as we know it today. His analyses of the gain–bandwidth product and of the effect on photoconductivity of traps and recombination centers form the basis for our understanding of the subject. His analysis of space-charge-limited currents in the presence of charge trapping was the basis for much of the later work in this area. Al's approach to these problems illustrates his characteristic, deceptively simple style. He always focused on the fundamental physics of a problem and tended to defer mathematical analysis until the basic concepts were clear.

In addition to his many papers, Al was the author of three books: *Concepts in Photoconductivity and Allied Problems* (Interscience, 1963), *Vision, Human and Electronic* (Plenum, 1973), and *Electron–Phonon Interactions* (World Scientific, 1989).

In recent years Al took an intense interest in the possibility of using solar energy to supply a considerable portion of the world's energy needs. Al's efforts were motivated by a deep concern for the future of humanity and by his desire to find a clean, lasting solution to the long-range energy problem.

Those who worked with Al Rose felt his profound influence on their work and in their personal lives. His many published works tell only part of the story. To an extraordinary degree he put his time and effort into helping younger colleagues and guiding their work. And to all his acquaintances he was an unfailing source of encouragement and good advice. Physicist and humanist, Al Rose was an inspiration to his friends and associates.

WALTER JOHNSON
PAUL K. WEIMER
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David Sarnoff Research Center
Princeton, New Jersey

Paul A. Anderson

Paul A. Anderson, past chairman of the physics department at Washington State University, died on 12 October 1990 in Carmel, California.

Anderson received his BS in physics from the University of Illinois in 1920 and his PhD from Harvard in 1923. Early in his career, he worked at Eastman Kodak Research Laboratories and at Yenching University in Beijing, China, and was a National Research Council Fellow at Harvard with Percy W. Bridgman. In 1931 he came to the State College of Washington (later Washington State University) as professor and physics department chairman. He headed the physics department until 1960 and retired in 1963.

At WSU Anderson initiated a program of research on electronic work functions that greatly extended the scope of existing methods of measurement and established a number of the work function values now accepted as standard. Techniques originated in this program have played a significant part in the development of surface physics and ultrahigh-vacuum production.

During World War II Anderson, working with his WSU colleagues S. Town Stephenson, Kenneth Fitzsimmons and Charles Barker, did radar research under the auspices of the Office of Scientific Research and Development. The four obtained results of fundamental importance to microwave propagation, and the application of these results took the WSU team to the Pacific war theaters in 1944–45. The work earned Anderson a Presidential Certificate of Merit with Citation.

After the war, Anderson became increasingly interested in biophysics. He developed methods for automatically recording the growth rates of microorganisms, for synchronizing division in microorganisms and for studying the effects of radiation on the synchronized cells.

Anderson was an admirable teacher. His students remember his enthusiasm for physics and his lectures in thermodynamics and modern physics, which were jewels of clarity.

PHILIP H. ABELSON
American Association for the Advancement of Science
Washington, DC
EDWARD E. DONALDSON
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Pullman, Washington

Clarence E. Bennett

Clarence Edwin Bennett, professor emeritus of physics at the University of Maine, died in his sleep on 19 December 1990 at his home in Orono, Maine. He was 88 years old.

Bennett earned bachelor's (1923), MS (1924) and PhD (1930) degrees in physics from Brown University. He was an instructor at MIT from 1931 until 1934, when he came to the University of Maine as an assistant professor of physics. Bennett became department head in 1937 and a professor of physics in 1940. He remained head of the department until his retirement in 1967. In his retirement Bennett served as the department's alumni secretary and wrote a carefully researched department history.

While at MIT, Bennett helped develop the recording spectrophotometer, but his long-term research interests centered around measurements of the optical properties of gases at high pressures using absolute interferometric techniques.

Bennett was a founding member of the physics division of the American

Society for Engineering Education, and early in his career he helped found the Maine Association of Physics Professors. As physics department head at the University of Maine, he initiated one of the first accredited undergraduate engineering physics programs in the US. Bennett wrote several widely used texts for introductory courses in physics, including *First Year College Physics* (Ronald Press), *Physics Without Mathematics* (Barnes and Noble), *Physics Problems and How to Solve Them* (Barnes and Noble) and *College Physics* (Barnes and Noble).

In addition to being a popular teacher, Bennett was a good role model for many students, a concerned and available adviser, a valued colleague—both within the department and in the university at large—and a national leader in physics education.

He will be missed by his many colleagues, friends and generations of students.

CHARLES W. SMITH
KENNETH R. BROWNSTEIN
University of Maine
Orono, Maine
CHARLES E. ARMENTROUT
University of Southern Maine
Portland, Maine

Malcolm Dole

Malcolm Dole, professor emeritus of chemistry at Northwestern University and Baylor University, died on 29 November 1990, at the age of 87. He was internationally renowned for his contributions to the study of electrolyte solutions, isotope effects and polymers.

Dole received both his undergraduate degree and his PhD from Harvard University, the latter in 1928. In 1930, after spending two years as a postdoctoral fellow at the Rockefeller Institute, he joined the faculty at Northwestern University. As a professor of chemistry there, he had a distinguished career lasting almost 40 years, including a four-year term as chairman of the Materials Research Center (of which he was also a founder). In 1969 Dole moved to Baylor University to become Welch Professor. He remained there until his retirement in 1982.

Dole's research with Theodore W. Richards and Grinnell Jones at Harvard focused on the properties of solutions of strong electrolytes, and in particular on their electrical conductances and transference numbers. During intermittent sojourns at Peter Debye's institute in Leipzig, Dole, with Hans Falkenhagen, extended Debye's electrolyte theory to explain the viscosity of dilute solutions. Working with Duncan MacInnes at the Rockefeller Institute, Dole constructed the first thin membrane glass electrode. At Northwestern Dole established an active experimental program on the glass electrode and also developed the theory behind it. His monograph *The Glass Electrode*, published in 1941, is still an authoritative source on the theory of the glass electrode.

In a study at Northwestern, Dole discovered an oxygen isotope cycle that made oxygen in air heavier than that in seas or lakes. His identification of this phenomenon—now called the Dole effect—was a major factor leading to the replacement of oxygen by carbon as the reference standard for atomic weights.

During World War II, Dole worked on a chemical warfare defense project at Northwestern, then became director of the Dugway Proving Ground operations in offensive chemical warfare, and finally joined the atomic bomb project, working on gaseous diffusion at Oak Ridge.

Back at Northwestern after the war, Dole designed and constructed exceptionally sensitive equipment for measuring specific heats and enthalpies of polymers. He discovered that polymers could be cross-linked by radiation, a phenomenon that has proved to be of great practical application. Both at Northwestern and at Baylor, Dole elaborated the fundamental molecular mechanisms in such cross-linking. He also made the pioneering steps in the development of a macromolecule mass spectrometer, a process that has only recently reached fruition in laboratories that followed up on his novel conceptions.

His personal relationships with students and colleagues were marked by the same enthusiasm and attentive interest that characterized his approach to scientific challenges. His strong views on personal rights, both his own and those of others, made him famous with the public through his legal encounters with authorities who tried to limit his rights to cycle to campus or with bandits who snatched his wallet. He was an exceptionally warm and good-humored individual who evoked admiration and affection in all who knew him. Malcolm Dole will be sorely missed by his family, colleagues, students, friends and all who had the good fortune to know him.

IRVING M. KLOTZ
MARK RATNER
Northwestern University
Evanston, Illinois ■