

nos and pursuing the underground detection of neutrinos produced by cosmic-ray interactions in the atmosphere.

A collaboration between Reines and Jacques P. F. Sellshop of the University of Witwatersrand, in Johannesburg, using a large-area liquid scintillation detector in a deep gold mine in South Africa, led to the first detection of atmospheric neutrinos in 1965. The investigation of atmospheric neutrinos was prescient, for it anticipated recent experiments such as Super Kamio-*kande*, which has produced striking evidence suggesting the existence of neutrino oscillation.

Studies that Reines undertook with Thomas L. Jenkins and F. E. Kinard at the Savannah River facility in 1969 detected, for the first time, the charged current interaction of electron antineutrinos with the deuteron. About ten years later, Reines worked with Elaine Pasierb, Henry S. Gurr, John Lathrop and Henry Sobel, and the corresponding weak neutral current interaction was observed. Another series of studies at Savannah River that involved Reines ultimately yielded the first detection (with Gurr and Sobel in 1976) of the electron antineutrino elastic scattering on electrons, providing important and timely information on the parameters of the electroweak theory of Sheldon Glashow, Abdus Salam and Steven Weinberg. In all of these experiments, many proceeding in parallel, Reines worked closely with students, postdocs and faculty colleagues. His coworkers remember his uncanny and almost intuitive ability to diagnose problems in an experiment.

In 1966, Reines left Case, and took the core of his neutrino group, to the newly built University of California campus at Irvine, where he became the founding dean of the school of physical sciences and where he remained for the rest of his professional career. He became distinguished professor in 1987 and professor emeritus in 1988.

While at UCI, in addition to his relentless pursuit of neutrinos, he indulged in one of his other great and long-standing interests—namely, the study of baryon conservation and the search for proton decay. His interest in this topic dated at least as far back as 1954, the year in which Reines, Cowan and Maurice Goldhaber had written a paper that reported an experimental lower limit on the lifetime of free protons of about  $10^{22}$  y. Several subsequent experiments involving Reines and various colleagues (Herald W. Kruse, Charles C. Giamati, William R. Kropp, Gurr, Basil Meyer, and Marshall Crouch) at Los Alamos and Case set increasingly more stringent limits

## A Toast

Here's to Wolfgang Pauli  
who made a funny joke  
Here's to the Great Enrico  
who then of weakness spoke  
Here's to all those gathered  
To celebrate the fruits  
Of all the patient workers  
Who followed those astutes  
Here's to the proposition  
That we shall meet again  
and Here's to the fond hope  
The sun will shine till then.

FREDERICK REINES

for various decay modes.

In the 1970s, as the advent of grand unified theories led to growing interest in baryon number violation, Reines's group at Irvine began a very large scale collaborative effort to search for proton decay. The result was the IMB (Irvine-Michigan-Brookhaven) experiment, which was conducted with an 8000-metric-ton water Čerenkov detector at a depth of 600 m in a salt mine near Cleveland, and was led jointly by Reines and Jack van der Velde of the University of Michigan. By the completion of the experiment in 1991, this effort had set the then-best lower limits on the proton lifetime (about  $10^{33}$  y), had obtained evidence for the atmospheric neutrino anomaly and had made the serendipitous detection of a burst of neutrinos from Supernova 1987A. The supernova observation, together with the coincident detection by the Kamiokande experiment in Japan, yielded the first experimental information concerning the role of neutrinos in stellar collapse, and is seen by many as the birth of neutrino astronomy. For Reines, it was a fitting and gratifying result, since he had always been mindful of the possibility of seeing neutrinos from stellar collapse. Indeed, his previous large detectors had been adorned with signs identifying them as "Supernova Early Warning Systems."

Although Reines will always be identified with the neutrino, he was also passionately interested in testing the fundamental conservation laws. His research included studies of charge conservation and the stability of the electron, and lepton conservation as probed in double beta decay, as well as basic physics laws, such as the Pauli exclusion principle. He also had a strong interest in, and contributed significantly throughout his career to, the development of new detectors—liquid scintillation and large water Čerenkov detectors, for example. An early pioneering contribution (1953) of his was

the use of liquid scintillation detectors to measure total body radioactivity.

In his contacts with colleagues, students and coworkers, Reines was a constant source of new ideas, stimulation and motivation. He was very generous in extending resources to colleagues to pursue their own ideas. This trait of his led to some outstanding research and advances achieved by colleagues, including Michael Moe in double beta decay, and Herbert Chen in accelerator and underground neutrino physics.

In his early years, Reines developed a strong interest in literature, music and theatre. While in college, he sang in choirs and performed major solo roles in oratorios, such as Handel's "Messiah." Indeed, his vocal abilities were so promising that he was encouraged to consider a singing career. Although he focused his attention and considerable energies on science, he retained a lifelong interest in singing and drama, performing in later years with the chorus of the Cleveland Symphony Orchestra. On a more informal basis, he frequently entertained his friends and colleagues with his deep-voiced renditions of folk songs and excerpts from Gilbert and Sullivan operettas.

Reines's physical stature, booming voice and natural, imposing stage presence invariably commanded attention. However, his interactions with people, especially the undergraduates he taught, were usually warmed by his penchant for the lighthearted use of quips, puns, riddles and the poems he was so fond of fashioning and reciting.

WILLIAM R. KROPP

JONAS SCHULTZ

HENRY W. SOBEL

*University of California, Irvine*

## Edward Leonard Ginzton

Edward Leonard Ginzton, the first director of SLAC and chairman of the board, president and CEO of Varian Associates for many years, died on 13 August 1998 in Palo Alto, California, after a long illness associated with Parkinson's disease.

Ginzton was born in the Ukrainian city of Ekaterinoslav (renamed Dnipropetrovsk in 1926) on 27 December 1915. When revolution swept through the Russian empire a short while later, the Ginzton family—like many others—sought refuge in the distant city of Harbin, Manchuria, where young Edward attended elementary school. In 1929, the family moved to San Francisco, where he attended high school after quickly mastering English.



EDWARD LEONARD GINZTON

Ginzton earned BS and MS degrees in electrical engineering in 1937 and 1938, respectively, from what is now the University of California, Berkeley.

In 1937, he went to Stanford University to work on a PhD in physics. Two years later, he joined William Hansen and the Varian brothers (Russell and Sigurd) to continue the development at Stanford of the klystron tube, the microwave device that had been invented by Russell Varian in 1937.

Since the Sperry Gyroscope Co held some of the patent rights to the klystron work, most of the members of the small Stanford klystron group moved in 1940 to the Sperry plant in Garden City, New York, where they developed radar for the military. That same year, Ginzton earned his PhD in physics from Stanford. At Sperry, Ginzton eventually became responsible for a staff of about 2000 people, who developed microwave measurement techniques and Doppler radar systems. His success in that role was early evidence of his superb administrative and managerial skills.

In 1946, after the end of the World War II, Hansen invited Ginzton to return to Stanford as an assistant professor in the physics department and to establish a new microwave laboratory for the physics and electrical engineering departments. Hansen and Ginzton were joined by Marvin Chodorow (who had also been at Sperry) and by Simon Sonkin (from City College). With an enthusiastic group of graduate students, they formed a team that was tremendously creative and productive. As one of those graduate students, I recall that we were treated as intellectual equals, learned a lot and had a great deal of fun.

Hansen's immediate objective was the development of electron linear accelerators using high-powered klystrons

(the goal was 30 megawatts of pulsed power) to drive the linacs. Ginzton believed such high power was attainable because the British had built a 20 kW pulsed power klystron during the war. Of course, the thousandfold increase to 20–30 megawatts challenged all of us, but no one told us young students that it could not be done. After a dramatic failure, we succeeded under Ginzton's leadership in designing and building many-megawatt klystrons by 1948–49.

In April 1948, Varian Associates was established as a corporate entity—"to conduct general research in the fields of physical science of every kind or nature," according to its articles of incorporation—with Ginzton as a member of the board of directors, a position that he held until his death.

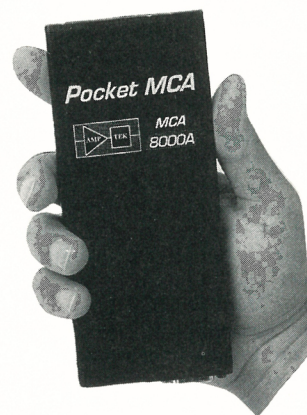
After Hansen died of a chronic lung illness in 1950, Ginzton took charge of the Microwave Laboratory and became its director. A year later, Wolfgang Panofsky joined the Stanford physics department from Berkeley. Subsequently, the lab was split into two parts: the Microwave Laboratory directed by Ginzton and the High Energy Physics Laboratory (HEPL) directed by Panofsky. The Microwave Lab continued its program of applied physics research and development, while HEPL carried out particle physics experiments with its 300-foot-long Mark III electron accelerator, which was the result of a successful proposal that Hansen had submitted to the Office of Naval Research in 1948.

In April 1957, Stanford submitted to the Atomic Energy Commission a document entitled "Proposal for a Two-Mile Electron Linear Accelerator." Initially known as Project M, the proposed facility became the Stanford Linear Accelerator Center after final AEC authorization in 1961. Ginzton was SLAC's first director; Panofsky was its deputy director and prepared the future experimental program.

Matters took an unexpected turn for Ginzton in 1959, when Russell Varian died in a plane crash. Soon after the accident, Ginzton was elected to replace Varian as chairman and CEO of Varian Associates. Faced with the difficult choice between his Project M and Varian responsibilities, Ginzton, after much soul searching, opted to lead the Varian enterprise that he had been so instrumental in creating.

Ginzton continued in this role at Varian, working to develop the company and to initiate new product lines. An example is the line of small medical electron linacs called Clinacs. There are now over 4000 Clinacs installed in hospitals around the world, treating more than 100 000 patients for cancer

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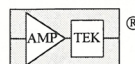


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every day. These machines were a source of great satisfaction to Ginzton, since his father had died of cancer, and since the very first medical electron linacs in the US had been designed and built at Stanford's Microwave Lab under his supervision in the 1950s.

As time passed, Ginzton eventually delegated some of his Varian duties to others, but he remained chairman of the board for many years. He finally gave up the CEO position when his health began to succumb to the progressive problems of Parkinson's disease. His mind remained clear, however, and his memory for detail persisted. His interest in SLAC continued throughout his life, and he often came to visit and to share in our achievements. More formally, he served as a special consultant to the president of Stanford to advise the president, if necessary, on the construction of SLAC from 1960 to 1966. And Ginzton was elected to Stanford's board of trustees for two consecutive terms (1977–1982, 1982–1985).

Ginzton possessed a rare combination of technical competence, managerial skills and leadership qualities. And for many of us in our early years as graduate students, he was not only a mentor but also a friend with a sincere concern for our well-being. He clearly remembered the difficult times that he had experienced in his youth and the friendship that he had received from Frederick Terman, Hansen, the Varian brothers and others in his own early career. He extended the same friendship to us. We shall all miss him.

**KARL L. BROWN**

*Stanford Linear Accelerator Center  
Stanford, California*

## Robert Alfred Laudise

The materials science community has lost one of its strongest proponents, Robert Alfred Laudise, who died at Memorial Sloan-Kettering Cancer Center in New York City on 20 August 1998. Bob was active not only as a research scientist and a scientific leader, but also as an industrial research manager, an adviser on many national and university committees and member of several scientific societies.

Born in Amsterdam, New York, on 2 September 1930, Bob earned a BS from Union College in 1952 and a PhD in inorganic chemistry from MIT in 1956. He then joined Bell Laboratories, where he had a distinguished research and managerial career until his death.

Bob is best known as a leading authority on the growth of single crystals and is often credited with transforming the field from an art to a



**ROBERT ALFRED LAUDISE**

science. He wrote the first comprehensive book on crystal growth, *The Growth of Single Crystals* (Prentice Hall, 1970).

In particular, he is widely recognized for his work in the area of hydrothermal crystal growth. His interest in this topic was spurred by the goal of synthesizing quartz with properties more reproducible than those of natural quartz and doing so at a reasonable cost. At that time, in the mid-1950s, the properties of quartz used in electronics varied from crystal to crystal and from mine to mine. By transferring his research from the lab, through a pilot plant and then to successful commercial production, Bob laid the foundations for the commercial growth of quartz crystals. By tonnage, quartz now ranks behind only silicon as the most widely used single-crystal material in electronics. Quartz crystals became Bob's trademark, and he gave many of them as gifts to colleagues.

As a manager of materials-related research at Bell Labs, Bob championed technologies based on new materials, their processing and reliability. His early nurturing of optical fiber research and his managerial persistence helped establish optical fiber as the backbone of modern communications systems. In retrospect, we note admiringly that he was a crystal grower who championed materials in all forms, from glass and glass fibers to thin films and nanoparticles.

Bob led not by just by managing but also by unselfishly contributing insights and inputs to all sorts of materials problems. His own research continued both during and after his formal managerial responsibilities. Over the years, he played key leadership roles in developing the growth of high-quality crystals of a number of important

materials, including lithium niobate, potassium titanyl phosphate, neodymium yttrium aluminum garnet, other garnets, ferrites and cuprate superconductors. At the time of his death, the programs he had initiated were continuing to investigate ferroelectrics, gallium nitride and organic semiconductors.

Widely recognized for his scientific and technical accomplishments, Bob was elected to the National Academy of Sciences, the National Academy of Engineering and the American Academy of Arts and Science. He received numerous prizes and awards for his work, including the Orton Lecture Prize of the American Ceramic Society, the Sawyer Prize for contributions to piezoelectricity, the Applications to Practice Award of the Minerals, Metals and Materials Society and the Materials Chemistry Prize of the American Chemical Society. In 1984, he was awarded the first experimental award of the International Organization of Crystal Growth, which was renamed the Laudise Prize in his honor in 1989. Bob was just as delighted when his colleagues received accolades, and he hosted many impromptu wine and cheese parties to celebrate.

Bob unselfishly served the scientific community. He belonged to and participated in at least ten professional societies and edited the *Journal of Crystal Growth* for 15 years and then the *Journal of Materials Research* until his death. He advised several national laboratories, universities and National Research Council committees and chaired the National Materials Advisory Board. He held adjunct professorships at MIT (materials science) and Rutgers University (ceramics). He labored aggressively to get the different professional societies to work together to positively influence government action related to materials research and development.

In recent years, Bob was instrumental in advancing the concepts of industrial ecology as a critically important field. He championed the AT&T (later Lucent Technologies) Fellowships in Industrial Ecology, a program that will now be administered on a continuing basis by the National Science Foundation.

Bob's interest in crystals and ecology extended to his vacation home in the Poconos. Along with his wife Joyce and other friends, he published an extensive database on the water quality of Twin Lakes to help evaluate the effects of acid rain and chemical usage in the area. Bob and Joyce also studied and wrote a paper on the growth on the lakes of single crystals of ice, which sometimes reach over three feet in length.

Bob will be remembered by the tech-