

more vivid than to Leo Szilard and Fermi, old friends in Europe, now partners and to a degree rivals around Columbia. Graduate student Feld walked step by step along the long path to the bomb. He was one of the very few who shared in those key early experiments on fission. When in 1942 the mushrooming project came under Army direction, he moved with Fermi and Szilard to Chicago, where he was one among the 40-odd people who helped to build and watched succeed the first of all neutron chain reactions. He worked there and at Oak Ridge, and as the war neared its end, he went on to Los Alamos to help wire the test bomb itself, that night when the desert sun would rise twice.

Feld came to MIT after finishing his Columbia PhD, begun before the war under Willis Lamb. It was not at all on fission, but on nuclear magnetic resonance in the presence of a nuclear quadrupole moment. Both experimenter and theorist, Feld extended his interests, first to neutron physics, then to particle physics, always staying close to the experimenters at the MIT Laboratory of Nuclear Studies (where he served for five years as director) until his retirement. His admirable text on early models of the elementary particles and their interaction (*Models of Elementary Particles*, Blaisdell, 1969) and his editing of the collected scientific papers of Szilard (*The Collected Works of Leo Szilard: Scientific Papers*, MIT Press, 1972) remain clear and direct, as was everything he did. He always was a prized teacher, with a flair for reducing complications to essential simplicity.

But all that is only his academic shadow. What quiet, steady Feld shared with quicksilver Szilard, who was for decades his friend and mentor, was an enduring and passionate sense of responsibility for ending the nuclear threat. His informed work and his wry opinions, both blunt and sharp, are found everywhere in that worldwide effort. The organizations he worked for (and often led) began in postwar Washington even before the founding of the Federation of Atomic Scientists. He served as first president of the Council for a Livable World, founded by Szilard in the late 1950s. Feld took part in almost every one of the international Pugwash Conferences, across the continents. For a few years he was on leave from MIT as executive head of Pugwash in London. The reference shelves hold many conference volumes he organized and edited on the technical and political issues of four

decades. His signature and his clarifying work appear in a myriad of documents. For some years during the 1980s he was editor of the *Bulletin of the Atomic Scientists*. The list is long; the lifelong statement is crystalline.

There were bad years, too, some of the trouble a sign of seriously failing health in the last decade. He published a volume bleakly entitled "A Voice Crying in the Wilderness" (Pergamon Press, 1979). But it is satisfying to report that in many conversations over the few years since *glasnost* came, Bernie welcomed as surprising but genuine the many signs that catastrophe is receding in the face of worldwide opposition to the waging of nuclear war.

There is one memorial Bernie Feld would most welcome: the determination of his colleagues—all of us—to ensure that the faint rosy glow where once nuclear darkness ruled the horizon is not another false dawn, like the first sunrise at Trinity long ago.

PHILIP MORRISON

Massachusetts Institute of Technology
Cambridge, Massachusetts

Bernard Peters

Bernard Peters, for more than four decades a world leader in probing cosmic rays, died at the age of 82 on 2 February 1993 in Copenhagen. Born in Posen (now Poznan in Poland), he grew up in academic circles in Germany between the wars. His bold early anti-Nazi activity as an engineering student in Munich brought him briefly to Dachau, but he soon found his way to the US, in 1934. A few years later, while a dockworker in San Francisco, he met Robert Oppenheimer through mutual friends, and soon he became one among Oppie's students. Peters took a PhD at Berkeley in 1942, then spent the war years working on the magnetic separation of ^{235}U .

Off to the University of Rochester at war's end, Peters formed a high-flying collaboration with another young group from the University of Minnesota. In 1948 they flew a package up to the last few grams/cm² of the air in a balloon. The package contained both a small cloud chamber for the Minnesotans and a large stack of photographic plates for Peters and Helmut Bradt, a colleague from Rochester who died, sadly, in 1950. The abundant heavy tracks confirmed for the first time that incoming cosmic rays are a mix of nuclei—starstuff like ourselves, somewhere and somehow smoothly accelerated to relativistic

energies, but not a primordial mystery of creation.

Soon the McCarthyite cold war chilled American campuses. Peters, although in no danger of a second concentration camp, nevertheless had real troubles to avoid and the high geomagnetic field at the equator still to exploit. Was there any antimatter in those cosmic rays? He was welcomed by Homi Bhabha to the Tata Institute of Fundamental Research in Bombay. There they promptly set a limit on antimatter, less than one antiproton among 1000. Soon Peters conceived another interest in the cosmic beam: It left radioactive tracers everywhere. Once you could ferret out a few dozen specific atoms from tons of meltwater you could study the mutual history of the rays and of the Earth.

Peters stayed in Bombay for eight busy years, happily engaged in such novel tasks as learning chemistry and a little Tamil, processing unprecedentedly large sheets of unbacked photographic emulsion, searching out downed balloons among suspicious, unlettered villagers and hauling heavy ion-exchange columns on horseback high into the Kashmir snows. The TIFR graduate students became devoted to this professor who worked harder than they did, would try out anything he could understand, earnestly explained everything he knew and through it all kept a helpful eye on them as his warm friends. His style is honored today in more than one successful Indian lab.

Peters left the tropics in 1958 to work at the Bohr Institute in Copenhagen. As Peters could improvise in the rickety Indian infrastructure, so he would innovate in the high-technology European context. If a gas at high pressure was a standard but cumbersome medium for Cherenkov detectors aloft, Peters had a better idea: Why not an artificial "gas," submicron hollow spheres of silica, custom-pressed to the density and refractive index of choice?

After a few years at the Bohr Institute Peters became director of the new Danish Space Research Institute, where his ingenuity and leadership informed many a productive space payload, even for the much larger agency, NASA. He retired in 1979, still able to challenge the experts with good new ideas about cosmic-ray origins. His personal glow as a cosmopolitan "teacher supreme," both through his pungent precepts and his reasoned if stubborn example, warms and illumines many who follow his path, fascinated as he was

by nature's secrets and eager for human welfare the world around.

BRUCE DAYTON

Carmel Valley, California

DEVENDRA LAL

University of California, San Diego

La Jolla, California

NIELS LUND

Danish Space Research Institute

Lyngby, Denmark

PHILIP MORRISON

Massachusetts Institute of Technology

Cambridge, Massachusetts

a great deal of time and effort to her undergraduate classes; her efforts were appreciated both by the students, who typically gave her standing ovations, and by the university. Further, she was a role model and mentor to generations of graduate and undergraduate students.

Phyllis is sorely missed by her family and all who came into contact with her, especially her students, colleagues and many friends.

C. JAKE WADDINGTON

University of Minnesota, Minneapolis

Phyllis S. Freier

Phyllis St. Cyr Freier died at home on 18 December 1992 after a long struggle with Parkinson's disease.

Phyllis had a long and fruitful association with the University of Minnesota. She received her BS from the university in 1942, her MA in 1944 and, after a stint at the Naval Ordnance Laboratory from 1944 to 1947, her PhD in physics in 1950. She remained at the university after graduation. Her thesis was based on the discovery she and her colleagues made of the presence of heavy nuclei in cosmic radiation. This demonstration of the close relation between ordinary matter and that in the cosmic radiation remains one of the key discoveries in astrophysics. It solved many of the problems vexing cosmic-ray physics at the time.

Phyllis went on to establish an international reputation as a cosmic-ray physicist and as an expert on the application of nuclear emulsions to a diversity of problems in astrophysics and physics. She and her colleagues studied the nature and composition of the primary cosmic radiation, looked for high-energy gamma-ray sources and investigated the production of energetic solar particles and the effects of solar modulation on the primary radiation. In later years she used emulsions to investigate the phenomena that occur during the interactions of relativistic heavy nuclei with other heavy target nuclei. She continued to display a keen interest in these topics until the day of her death.

Phyllis played an important role in the physics community, serving on both APS and NASA committees and as an APS councillor. At the same time she served her university in many capacities on senate and college committees.

Phyllis proved to be an inspiring and dedicated teacher once the nepotism rules were relaxed to allow her to play such a role. (Her husband was also on the faculty.) She devoted

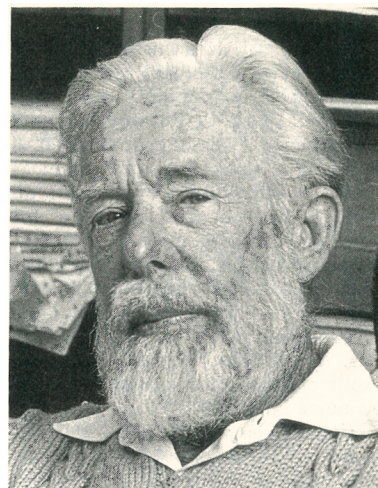
Oscar Buneman

Oscar Buneman, emeritus professor of electrical engineering at Stanford University and a contributor to plasma electrodynamics, fundamental electromagnetic theory and numerical analysis, died on 24 January 1993.

Born 28 September 1913 in Milan, Italy, Buneman was educated in Hamburg, Germany. He was imprisoned by the Nazis for political resistance, and on his release in 1935 he went to Manchester University, England for his BA and MA degrees in mathematics. At the outbreak of war in September 1939 he was interned for nine months in Canada with other foreign nationals. On returning to Manchester, Buneman completed a PhD supervised by Douglas Hartree in 1940 and then used a primitive analog computer developed at Manchester to discover the bunching of particles and the "Buneman potential" that exists in a cavity magnetron.

In 1944, as a member of the British mission to the Manhattan Project at Berkeley, Buneman worked on ion optics for the calutron isotope separation device. In 1945 he transferred to the Canadian reactor project, and from 1946 to 1950 he worked in the Atomic Energy Research Center at Harwell, England. For the next ten years, Buneman was a lecturer in mathematics at Cambridge University. From 1960 until 1984 Buneman was professor of electrical engineering at Stanford University.

In the 1960s Buneman, with Roger Hockney, developed a fast, direct method for solving Poisson's equation using a two-dimensional spatial grid, which made electrostatic simulation attractive and economical and eventually superseded the method of summing Coulomb interactions. These activities proved relevant to electron streaming in the magnetosphere and to the impact of the solar wind. With Ken-Ichi Nishikawa, Torsten Neubert and Dong Sheng Cai, Bune-



Oscar Buneman

man developed TRISTAN, a three-dimensional electromagnetic particle simulation code for Cray supercomputers, which showed the dramatic kinematics of formation of the bow-shock, the magnetospheric cavity, the magnetotail and other features of the magnetosphere known from observation, and that reproduced the transient behavior associated with the flapping of the solar wind sheet. Ultimately he simplified the self-consistent field approach to the point where all of the particle behavior could be deduced directly from Newton's equations of motion and Maxwell's equations without Poisson's equation or magnetohydrodynamics.

Buneman gave his courses at Stanford an inimitable mathematical and computational flavor. As the trend to improved high-level languages advanced, Buneman stressed the continued need for meticulous attention to microprogramming. The power of his TRISTAN code is a testimony to the effectiveness of combining basic knowledge of electrodynamics with an intimate understanding of machine fundamentals.

Buneman's graduate students remember the inspiration he brought to regular research discussions as well as his personal kindness. He loved the outdoors, spending as much time as possible with his family in the mountains and sun. He liked sleeping in the open (even at home, on his deck), swam regularly and, until late 1992, was a familiar sight in brief shorts and an ancient crash helmet, riding his racing bicycle to his office. He will be very much missed by his colleagues.

RONALD N. BRACEWELL

Stanford University

Stanford, California ■