IN MEMORIAM

HERBERT LESTER BERK

Professor Herbert Lester Berk was born in 1938 in New York City to Murray and Elsie Berk. He had two siblings, his sister Renee and his brother David. His love of science and mathematics developed while he attended the Bronx High School of Science, where he enjoyed the keen competition. Continuing to university, he attended NYU [New York University] where he earned an undergraduate degree in Engineering Physics before completing a masters and PhD in Astrophysics at Princeton University. His 1964 dissertation, directed by Professor Carl R. Oberman, was entitled, "Electrical Transport Equation for a Plasma Model."

Known to his family and colleagues as Herb, he met his wife Susan J. Rich in California. They were married in November of 1962 in Los Angeles. Their oldest son Joseph was born in 1967 and their youngest son Adam in 1970. In his free time, he enjoyed fishing, camping, and hiking with his family.

Herb devoted his career to the investigation of plasma physics with the goal of developing an energy source from nuclear fusion. His commitment to that goal remained passionate throughout his life. During his first postdoctoral appointment he worked with Keith Roberts at the newly created Culham Laboratory. Together they developed a new numerical algorithm for simulating the phase-space dynamics of plasma beams by treating them as a collection of phase-space "water bags." This method offered both conceptual and practical advantages over competing methods. Herb's next appointment took him to the Center for Theoretical Physics in Trieste, Italy. With Russian fusion pioneer Albert Galeev, he wrote an influential investigation of the orbits and destabilizing influence of trapped particles in tokamaks. An entire generation of plasma theorists learned about tokamak orbits and their significance from this celebrated paper.

Perhaps the most famous contributions of his early career involved magnetic mirror confinement, an approach whereby particles are confined in a region of low field (as they are in the earth's Van Allen belts). No scientist played a larger role in constructing the theory of mirror stability than Herb Berk. He made truly pivotal advances in such areas as loss-cone modes, convective instabilities, and trapped particle instability. He returned to mirror physics in the late 1970s, using quasilinear theory to help explicate the mysteriously good confinement often observed in mirrors. Berk brought to this work an exceptionally deep understanding of kinetic instability mechanisms, insights that he had developed in various non-mirror contexts. Probably the most famous example is his analysis, with Don Pearlstein, of drift wave stability. This analysis introduced a method for determining the stability of negative energy waves, such as the turbulence found downstream of windmills after energy has been extracted from the wind. Their analysis (despite its need for later correction) has affected thinking about kinetic plasma stability as much as any other single work in the area. It has even entered the vocabulary, through such language as Berk-Pearlstein modes and the Berk-Pearlstein mechanism.

Herb Berk became a tenured professor in the Physics Department at the University of Texas at Austin in 1980 and was a founding member of the Institute for Fusion Studies. His wide-ranging curiosity suited him especially for another major preoccupation of his career: the evaluation of alternative concepts in plasma confinement. His insights on various unconventional schemes have been deep and influential; they include studies of such devices as the astron, the two-component torus, bumpy tori, tandem mirrors, the migma concept, and the field-reversed configurations (the latter of which has become the basis for the successful private fusion company TAE technologies).

His paper on sharp-boundary equilibria for stellarators has recently been used in a mathematical demonstration of the conditions for the existence of three-dimensional equilibria with pressure.

The imagination and depth that characterized Herb's studies of specific plasma confinement devices was also apparent in his more abstract mathematical investigations. His extension of WKB methodology to systems of integral equations marks a notable advance in mathematical physics. He similarly introduced powerful variational approaches into the kinetic instability theory; the Berk-Dominguez variational method is now an established tool.

As the fusion program increasingly focused on the tokamak as the most promising confinement device for achieving fusion, Herb concentrated his efforts on the physics of fusion-produced energetic alpha particles in burning plasma. This is directly relevant to current investigations of thermonuclear plasmas (such as the deuterium-tritium experiments being conducted in the JET tokamak), as well as the ITER project. Herb played a leading role in the definitive analysis of continuum damping on the toroidicity-induced Alfven eigenmode (TAE), which, when balanced with the alpha particle excitation, is instrumental in setting the instability threshold; these predictions have been compared with the experimental observations of TAE oscillations in which beam-injected fast ions were used to simulate the effect of alpha particles.

Perhaps the most interesting and novel aspect of this research program was Herb's development, in collaboration with Boris Breizman, of an elegant theory of the nonlinear behavior of the TAE instability. They constructed, from simple and fundamental principles, a remarkable theory whose predictions for the saturation amplitude are consistent with experiment and simulation. The most recent developments of this theory seem to explain, self-consistently, the bursting phenomenon observed in TAE fluctuation experiments. Considered as whole, this nonlinear theory constitutes an extraordinary scientific accomplishment.

Herb was elected a fellow of both the American Physical Society and of the American Society for the Advancement of Science. His integrity is famous throughout the plasma scientific community. He was a dedicated scientist who cared deeply about the quality of his work and the health of his field.

Herb was also an ardent supporter of international collaboration and a champion of human rights. He chaired the American Physical Society Committee on International Freedom of Scientists. Spurred by his unwavering interest in minority participation in research, he led the Department's participation in the Underrepresented Minority Bridge program of the American Physical Society. Herb performed this task with skill and tireless dedication.

Herbert Berk is survived by his son Joseph Berk, his daughter-in-law Loretta Berk, his son Adam Berk, his daughter-in-law Pennie Berk, his grandchildren Hannah, Mason, Lauren, and Emma,his sister Renee Rocklin and brother David Berk. In his memory, his family has established the Herbert L. Berk Endowed Graduate Fellowship in Physics.

Jay C. Hartzell, President
The University of Texas at Austin

Charlotte Canning, Secretary
The General Faculty

This memorial resolution was prepared by a special committee consisting of Professors Richard Hazeltine, Phil Morrison, Sonia Paban, and Francois Waelbroeck.