witty presentations of quantum mechanics and quantum field theory. Some of his legendary lectures were recorded for posterity; others were saved as lecture notes by diligent students so that their successors might have a taste of Sidney's inimitable style.

In 2005 Harvard hosted a festival to honor Sidney. In attendance were many of his former students and many distinguished physicists. Steven Weinberg remarked that "Sidney is a theorist's theorist. He has not been so much concerned with accounting for the latest data from experiments as with understanding deeply what our theories really mean. I can say I learned more about physics from Sidney than from anyone else." In that connection let me recall an oft-told tale: Working late into the night as was his wont, Sidney rarely appeared at Harvard much before noon. He once arrived so late at a seminar by Weinberg that all he heard was Steve's uncertain response to a question from the audience. "I know the answer!" shouted Sidney on entering the room, "What's the question?" Indeed, he often answered questions before they were asked. Theorists who consulted him were often astounded as Sidney would patiently explain the implications of their own ideas.

Sidney was both an incomparable teacher and the most learned sage and sharpest critic in the world of theoretical physics: He was Pauli's tongue in Einstein's image. We have been deprived all too soon of one of our generation's most profound and imaginative minds.

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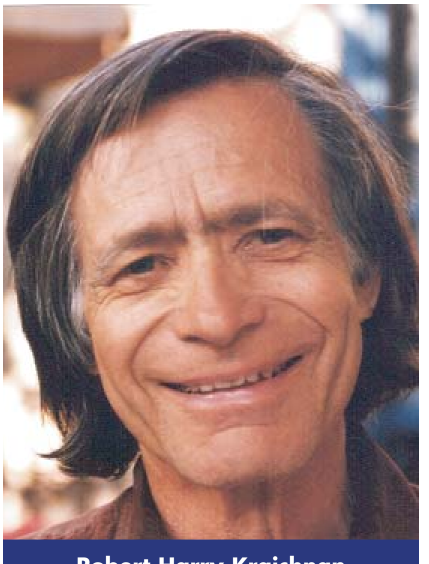
Robert Harry Kraichnan

When Robert Kraichnan died on 26 February 2008 at his residence in Santa Fe, New Mexico, after a long illness, the world lost a profound and original theoretical physicist. He contributed much to our current understanding of fluid turbulence, the subject that occupied him for most of his career, and also made fundamental contributions to general relativity, quantum field theory, quantum many-body theory, and statistical physics.

Kraichnan was born in Philadelphia on 15 January 1928. His earliest scientific interest was in general relativity, which he began to study on his own at age 13. At age 18 he wrote at MIT a prescient undergraduate thesis, "Quantum Theory of the Linear Gravitational Field"; he received a PhD from MIT in 1949 for his thesis, "Relativistic Scattering of Pseudoscalar Mesons by Nucleons," supervised by Herman Feshbach. He was one of Albert Einstein's last assistants at the Institute for Advanced Study in Princeton, New Jersey, in 1949–50. Kraichnan developed an approach to gravitation that started from the linear wave equation of a spin-2 massless particle and recovered nonlinear general relativity by a bootstrap. His viewpoint is now popular among high-energy physicists, but Einstein viewed it with disfavor. Some of Kraichnan's ideas were rediscovered by Richard Feynman when he taught a course on gravity in 1962–63. The brilliance and strong individualist streak that were evidenced in his early work became hallmarks of Kraichnan's entire career.

After leaving the institute, Kraichnan worked at Columbia University and the Courant Institute of New York University. In the 1950s and 1960s, he made important contributions to several areas of theoretical physics, in particular to quantum field theory and the quantum many-body problem. At the time, so-called self-consistent approaches, which resummed infinite subsets of diagrams, became popular. In 1957–62 Kraichnan developed an ingenious method of realizing such approximations as exact solutions of large-N random-coupling models that couple N copies of the microscopic equations with quenched random parameters. Similar techniques using random matrices were rediscovered by Gerard 't Hooft, Alexander Migdal, and others in the 1980s and applied to chromodynamics and quantum gravity. Kraichnan's field-theoretic approach to nonequilibrium quantum statistical mechanics is equivalent to the formalism developed by Julian Schwinger and Leonid Keldysh around the same time.



Robert Harry Kraichnan

In the late 1950s, Kraichnan tackled the famously difficult subject of fluid turbulence. He became a world leader on the subject and drove major developments for a remarkable 40-year span beginning around 1957. For many workers in fluid turbulence, it was enough to say "Bob said. . . ." In 1962 Kraichnan decided on an unusual career path, leaving academia and setting up his own scientific consulting business. He became an independent research scientist, located first in New Hampshire and later in New Mexico. His work was funded by grants from agencies such as the Office of Naval Research, NSF, and the Department of Energy. He had long associations with the National Center for Atmospheric Research and Los Alamos National Laboratory.

Kraichnan made deep and seminal discoveries on turbulence in many physical systems, as varied as magnetohydrodynamics, Rayleigh–Benard convection, and superfluids. In 1957 he used the same ideas as in his work on quantum statistics to develop a self-consistent theory called the direct-interaction approximation (DIA), whose Lagrangian reformulation in 1964–66 yielded a quantitative mean-field theory of turbulence. Those works were the first to provide fundamental insights into the origin of Lord Kelvin's concept of "vitiating rearrangement" and the consequent loss of memory and eddy viscosity in turbulent flow. The DIA has been applied to diverse problems in fluid turbulence and was an important predecessor to the modern field-theory formalism of Paul Martin, Eric Siggia, and Harvey Rose.

Kraichnan also discovered the phenomenon of inverse energy cascade in two-dimensional turbulence. Building on earlier work of Lars Onsager, T. D. Lee, and others, Kraichnan predicted in 1967 that there should be a Kolmogorov-like energy cascade in 2D fluids with a $-5/3$ power-law energy spectrum but with energy transferred from small scales to large scales, the opposite direction as in 3D. That idea has proved extremely influential in our current understanding of the fluid dynamics of Earth's atmosphere and oceans. Inverse cascade has been cleanly observed in laboratory experiments in the past several years, and strong evidence has been found for the process in the oceans and atmosphere.

Additionally, Kraichnan contributed a large body of work on passive scalars in a turbulent flow, including his introduction in 1968 of an exactly soluble model of advection by a velocity field white-noise in time. In a pivotal 1994 *Physical Review Letter*, Kraichnan proposed that the scalar field in that model should develop anomalous scaling not captured by mean-field theory. The observation led to spectacular developments in turbulence theory in the 1990s, with successful calculations of the scaling exponents of the passive scalar. The Kraichnan model is now widely hailed as the "Ising model of turbulence."

Kraichnan received the 1993 Medaille de l'ADION from France's Observatoire de la Côte d'Azur, the American Physical Society's 1993 Otto Laporte Award and 1997 Lars Onsager Prize, and the 2003 Dirac Medal from the Abdus Salam International Centre for Theoretical Physics. Kraichnan was elected in 2000 to the National Academy of Sciences and became in 2003 Homewood Professor of the Johns Hopkins University.

In addition to his achievements in physics, Kraichnan enjoyed classical music and was an accomplished violinist. He was also, in better days, an avid hiker who took long daily walks and thought deeply about science as he hiked. Much of his best work was done while walking the hills of New Hampshire and the canyons of New Mexico.

With Kraichnan's passing, the physics community has lost a truly original theorist. He was a unique and solitary thinker, but never isolated. Throughout his career, he took special interest in mentoring new researchers and was extraordinarily generous in sharing his own ideas. His many colleagues and friends will remember his warm and kind presence and his penetrating insights. We'll miss him very much.

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