then became a professor of aeronautical engineering at Cornell University. He joined the University of Arizona in 1974, where he is now a professor emeritus in the department of aerospace and mechanical engineering.

Also recognized at the fluid dynamics meeting was William C. Reynolds, who received the Otto Laporte Award. APS cited Reynolds for "his experimental, theoretical and computational work on turbulent flows, including innovations in turbulence modeling and control, and his leadership in direct numerical simulation and large eddy simulation."

Reynolds has spent almost his entire career at Stanford, where he earned a PhD in mechanical engineering in 1957 and then joined the faculty. He is currently a professor of mechanical engineering and chairman of the department there.

AAS PLANETARY SCIENCE AWARDS PRESENTED IN MUNICH

The division for planetary sciences of the American Astronomical Society presented several awards at its 1992 annual meeting, held in Munich in October. Peter Goldreich of Caltech received the Gerard P. Kuiper Prize; Jack J. Lissauer of the State University of New York at Stony Brook received the Harold C. Urey Prize; and Harlan J. Smith, formerly of the University of Texas at Austin, was posthumously honored with the Masursky Award for Meritorious Service.

Goldreich was chosen "in recognition of sustained and fundamental contributions to problems in planetary science"—in particular his studies of the origin of the Moon, the effect of tidal forces on the orbits and spins of planets and their moons, the formation of the solar system and the dynamics of planetary rings. His current research deals with solar oscillations.

Goldreich earned a PhD in physics from Cornell University in 1963. After working at Cambridge University and the University of California, Los Angeles, he joined the Caltech faculty, where he is now the Lee A. Dubridge Professor of Astrophysics and Planetary Physics.

The Urey Prize, which recognizes achievements by a young scientist, was given to Lissauer for his "observational and theoretical research on fundamental problems in celestial mechanics." Lissauer has studied the complex resonant structure of the orbits of co-orbital satellites; he pioneered theoretical investigations of corotation resonances as a cause for Neptune's ring arcs; and he proposed and developed dynamical models of planetary formation.

Lissauer earned a PhD in applied mathematics from the University of California, Berkeley, in 1982. He was next a postdoctoral fellow, first at NASA Ames Research Center and then at the University of California, Santa Barbara. He is now an assistant professor in the department of Earth and space sciences at Stony Brook.

Smith, the recipient of the Masursky Award, played a key role in obtaining NASA funding for ground-based observatories during the 1960s, and later, as chair of the NASA Space Science Board committee on space astronomy and astrophysics, he was a leading proponent of the Great Observatories series of orbital telescopes.

Smith earned a PhD in astronomy in 1955 from Harvard. He was a member of the astronomy faculty at Yale before joining the University of Texas in 1963. He directed the McDonald Observatory there for 26 years. At the time of his death, in October 1991, Smith was the Edward Randall Jr Centennial Professor in Astronomy.

IN BRIEF

The winner of the 1992 Kilby Young Innovator Award is **John Hagelin**, chair of the physics department at Maharishi International University in Fairfield, Iowa. He was cited for "his pioneering work in the field of supersymmetric unified quantum field theories, for his relentless pursuit of the answers to compelling global issues, and for his innovative accomplishments in digital music reproduction."

Richard Smalley was a 1992 Kilby Award winner for his discovery of buckminsterfullerene, C_{60}, also known as the buckyball. He is a professor in both the chemistry and physics departments at Rice University. In October Smalley also received the 1992 Robert Welch Award in Chemistry from the Welch Foundation in Houston in recognition of "his outstanding contributions to the field of physical chemistry."

Oak Ridge National Laboratory and the University of Tennessee have named **Ward Plummer** as Distinguished Scientist. He was previously William Smith Professor of Physics at Pennsylvania State University.

OBITUARIES

Pavel Alexeyevich Cherenkov

Pavel A. Cherenkov, head of the department of high-energy physics of the P. N. Lebedev Institute of Physics of the Academy of Sciences of the USSR, died on 6 January 1990.

Cherenkov was born on 28 July 1904 in the middle of Russia, near Voronezh, and graduated from the University of Voronezh in the department of physics and mathematics in 1928.

In 1930, after teaching in a high school, Cherenkov moved to Leningrad and entered the Institute of Physics and Mathematics of the Academy of Sciences of the USSR as a postgraduate student. In 1932 he started his research, under Sergei I. Vavilov, on luminescence activated by gamma rays in different liquids. Shortly thereafter the institute's department of physics, which Vavilov headed, was transformed into a new institute—the P. N. Lebedev Institute of Physics—and transferred to Moscow. Although at that time it was quite a small research institution, it nevertheless had already attracted several bright physicists. Cherenkov's research activity and scientific career were closely connected with the history of the institute, at which he spent the remaining 56 years of his life.

Cherenkov's first five years of research under Vavilov were crowned by the discovery of the beautiful phenomenon named after him, Cherenkov radiation, and its interpretation by Ilya M. Frank and Igor E. Tamm.

In 1946 Cherenkov joined Vladimir I. Veksler to construct electron accelerators, first the betatron and then a

Pavel Alexeyevich Cherenkov

250-MeV synchrotron. The latter became the basic instrument, for more than a decade, of the Lebedev Institute's Photo-Meson Laboratory, which Cherenkov headed from 1959 to the end of his life. Studying the electromagnetic interactions of particles became his main occupation. In the 1970s he improved the facilities of the laboratory by directing the construction of a new 1.2-GeV synchrotron. Cherenkov's laboratory collaborated successfully with many centers for research on electromagnetic interactions at high energies, among them Dubna, Serpukhov, CERN and DESY.

Cherenkov's full scientific career could be described in more detail, but I would like to concentrate here on one outstanding feature, one "hour of destiny"—the discovery of Cherenkov radiation. The phenomenon was not and probably could not have been discovered earlier by somebody more experienced in physics than Cherenkov was in the 1930s. To determine the nature of the faint blue light produced in different liquids by gamma rays from a radioactive source seemed to require a young fellow from a rural area, inexperienced but with immense patience and vigor.

It took a long time for Cherenkov and his colleagues, the brilliant physicists Frank and Tamm, to find the right explanation for the phenomenon. Cherenkov was certainly lucky to perform his extremely difficult experiments at the Lebedev Institute, with its creative atmosphere and the favorable attitude of its staff. He was constantly encouraged by Vavilov, who clearly recognized that the phenomenon under investigation was not luminescence but a new effect deserving thorough study. Frank enthusiastically took part in some experiments and suggested many ideas, including the analogy between the Cherenkov effect and an acoustic shock wave, emphasizing that the electron should move through matter with a velocity greater than the velocity of propagation of electromagnetic waves in the same matter.

But the majority of Cherenkov's colleagues did not show particular interest in his results. Nobody recollected the calculation by Arnold Sommerfeld in 1905 of the energy losses of an electron whose velocity exceeds the velocity of light, or the incredible intuition of Oliver Heaviside, who actually predicted the Cherenkov effect in 1888. Even as distinguished a physicist as Leonid I. Mandelstam did not show much interest in Cherenkov's results, being quite sure that an electron moving with constant velocity could not emit radiation.

Only Cherenkov's discovery of the asymmetry of the radiation, made (partly by chance) in 1936 after several years of intense experimenting, assured him and his fellow researchers of the reality of the phenomenon and gave them the key to understanding it. The angle between the electron trajectory and the emitted light was found to be in agreement with the Huygens principle. Finally in 1937 Tamm developed a theory, based on classical electrodynamics, that perfectly predicted the experimental data on the angle and intensity of Cherenkov radiation.

But acceptance of the effect did not come easily. In the middle of 1937 the editor of *Nature* declined to publish Cherenkov's paper, entitled "Visible Radiation Produced by Electrons Moving in a Medium with Velocities Exceeding That of Light." Later in 1937 *Physical Review* published the paper, and soon the phenomenon was confirmed and accepted. In the same year Cherenkov noted the possibility of using the effect for measurement of the velocities of relativistic charged particles. This possibility was realized much later, with the improvement of the technique of recording the feeble flashes of light using photomultipliers or image intensifiers.

The Cherenkov technique is now the main tool for distinguishing particles of different masses in accelerator experiments. The momentum of the particle is measured by magnetic deflection and its velocity by using the angle or intensity of the Cherenkov light. The technique of measuring Cherenkov radiation in gases works up to energies of more than 100 GeV.

Another widely used application is the Cherenkov calorimeter, or total absorption spectrometer. The whole field of gamma-ray astronomy and important underground experiments—in particular those detecting neutrinos from natural sources—are now based on this technique. Cherenkov detectors are also a customary part of satellite- and balloon-borne instruments for studies of primary cosmic rays.

But the importance of Cherenkov radiation is not exclusively connected with its extensive practical applications in experiments in high-energy physics. It is also remarkable for its universal general nature. It may have been the last important basic phenomenon in classical electrodynamics that remained to be discovered.

How did Cherenkov react to the tremendous delayed resonance in the application of his discovery? Always a modest individual, he was extremely scrupulous not to pretend to be involved in the developing applications just because of his contribution to the effect's discovery. He even may have avoided using the Cherenkov technique in his own experiments.

When the Nobel Physics Prize was awarded in 1958 to Cherenkov, Frank and Tamm, it was not Cherenkov but Tamm who asked me to acquaint him with the recent developments of the Cherenkov technique. Limiting his own contribution to the period of the 1930s, Cherenkov at the same time always emphasized the crucial role of Vavilov, Frank and Tamm in the discovery.

Nevertheless, when considering the glorious development of the Cherenkov technique in experimental physics, I imagine a young and enthusiastic fellow who for several years started his working day by spending an hour in a totally dark room to prepare his eyes to observe faint light, and who scrupulously repeated the observations again and again, varying the liquids and the geometry of the experiment, trying to find the clue to the nature of the puzzling radiation that now bears his name.

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Fred H. Schmidt

Fred H. Schmidt, an emeritus professor in the physics department of the University of Washington, died on 17 January 1991 in Seattle, Washington.

Fred was born on 12 September 1915 in Detroit, Michigan. He received his BSE degree in engineering physics from the University of Michigan, and after a brief period as an engineer with AT&T he realized that his deeper interest lay in physics. He entered graduate school in physics at the University of Buffalo and continued at the University of California. During World War II he worked on the Manhattan Project at Berkeley, Oak Ridge and Los Alamos. In 1945 he was awarded a PhD for a study of ion sources under Ernest O. Lawrence.

Fred joined the faculty of the University of Washington in 1946 and became a full professor in 1956. He was the prime mover in the construction and development of its accelerators, a 60-inch cyclotron and later a three-stage tandem Van de Graaff facility. The strong program at Washington's Nuclear Research Laboratory owes much to his many technical contributions and to his insistence on democratic management.

In parallel with building the cyclo-