NATIONAL MEDALS OF SCIENCE PRESENTED AT WHITE HOUSE CEREMONY

On the morning of 16 September 1991, in the Rose Garden of the White House, President Bush conferred 20 National Medals of Science and 15 National Medals of Technology on this year's recipients. The medals are the nation's highest recognition for scientific achievement.

Among the science recipients were George H. Heilmeier, president and CEO of Bellcore; Dudley R. Herschbach, the Frank B. Baird Jr Professor of Science at Harvard University; Arthur L. Schawlow, the J. G. Jackson and C. J. Wood Professor of Physics at Stanford University; Glenn T. Seaborg, associate director of Lawrence Berkeley Laboratory and a professor of chemistry and of education at the University of California, Berkeley; H. Guyford Stever, a member of the Carnegie Commission on Science, Technology and Government; Edward C. Stone, director of the Jet Propulsion Laboratory and a professor of physics at Caltech; and Steven Weinberg, the Josey Regental Professor of Science at the University of Texas, Austin.

Among the recipients of the technology award was James J. Duderstadt, president of the University of Michigan and a professor of nuclear engineering there.

Heilmeier was cited for "his major contributions to the technological competitiveness of the United States and to the cause of national defense." His research has included work on parametric amplification, tunnel diode down-converters, millimeter-wave generation, ferroelectric thin film devices and organic semiconductors. His research on electro-optical effects in liquid crystals demonstrated a way to control electronically the reflection of light from a material. This work led to the development of liquid crystal displays now used in many devices, including watches and calculators. Heilmeier spent several years as an executive in defense research development and engineering for the Federal government. He was involved in major night vision and stealth technology projects.

Heilmeier received his PhD in solid-state materials and electronics from Princeton University in 1962. He became a member of the technical staff of RCA Laboratories after graduating and stayed there until 1970. Beginning in 1970 he held a series of senior research executive positions with the Department of Defense, culminating in the directorship of the Defense Advanced Research Projects Agency in 1975. He joined Texas Instruments late in 1977 and became senior vice president and chief technical officer in 1983. He has been president and CEO of Bellcore since March 1991. [Heilmeier was a participant in the roundtable discussion "Science Under Stress," which begins on page 38.]

Herschbach's citation noted his "seminal contributions to the fundamental understanding of reactions of atoms and molecules, collision by collision." Beginning in the early 1960s Herschbach studied the dynamics of reactions of alkali atoms with alkyl iodides, discovering that the product molecules had a preferred range of recoil angles and translational energies. Together with Yuan Lee and other coworkers at Harvard, Herschbach developed an extremely sensitive mass spectrometric apparatus and extended these studies to other reactions. This work established that several prototype modes of reaction dynamics could be correlated with the electronic structure of the target molecule, enabling reaction dynamics to be interpreted in terms of electronic structure. Herschbach and Lee shared the 1986 Nobel Prize for Chemistry with John Polanyi of the University of Toronto. Herschbach and his current coworkers are developing methods for orienting molecules in space to avoid averaging over their random rotations, studying bulk liquid interactions and computing electronic structures by a dimensional scaling method.

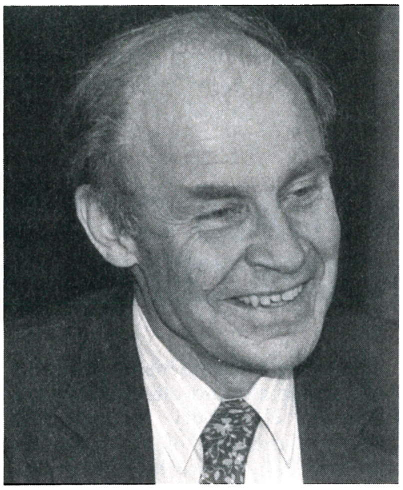
Herschbach earned his PhD in chemical physics at Harvard in 1958. After two years as a junior fellow at Harvard, he joined the chemistry department at the University of California, Berkeley. In 1963 he returned to Harvard as a professor of chemistry. He served as chair of the department from 1977 to 1980. Since 1976 he has been Baird Professor of Science, and he views teaching freshman chemistry as one of his most challenging tasks.

Schawlow's citation noted his "role in the conception of the laser and in advancing its applications, especially in laser spectroscopy." In 1958 Schawlow and Charles Townes published a paper that described how to build a laser, a device they developed along the principles of the maser. Schawlow and Theodor Hänsch, and independently Hans Dehmelt and David Wineland, developed laser cooling, which eliminates the broadening of spectral lines caused by the thermal motions of atoms and molecules and enables observation of small detail. Schawlow has also performed experiments in optical and microwave spectroscopy, nuclear quadrupole resonance and superconductivity.

Schawlow received his PhD in physics in 1949 from the University of Toronto. He was a postdoctoral fellow at Columbia University for two years, worked as a research physicist at AT&T Bell Laboratories and then returned to Columbia for a year in 1960. Since 1961 he has been a professor of physics at Stanford University, where he was chairman of the department from 1966 to 1970 and in 1973–74. He shared the 1981 Nobel Prize for Physics with Nicolaas Bloembergen and Kai M. Siegbahn.

Seaborg was given the medal in recognition of "his outstanding work as a chemist, scientist and teacher in the field of nuclear chemistry." Seaborg was the codiscoverer of plutonium with Edwin McMillan, and they shared the 1951 Nobel Prize in Chemistry for their work on the chemistry of transuranium elements. During World War II, Seaborg headed a group at the University of Chicago's Metallurgical Laboratory that developed plutonium extraction processes

George H. Heilmeier



Dudley R. Herschbach

Arthur L. Schawlow

for the Manhattan Project. He was also the codiscoverer of americium, curium, berkelium, californium, einsteinium, fermium, mendelevium, nobelium and element 106, as well as of isotopes of several other elements. His current research at LBL continues the search for new elements, including superheavy elements (elements that may be found at or above atomic number 114, at which point theory predicts a relatively stable nuclear configuration).

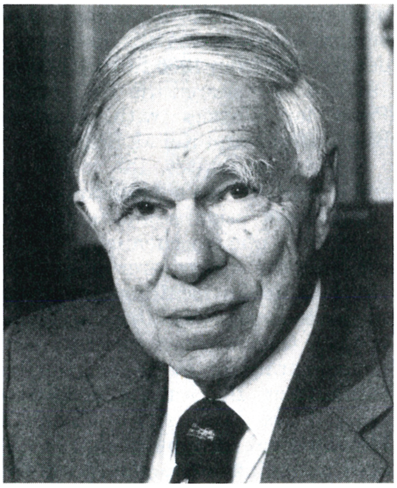
Seaborg got his PhD in chemistry in 1937 from the University of California, Berkeley. He worked at the Radiation Laboratory there, the forerunner to LBL, and joined the university's chemistry faculty in 1939. He is now also a professor in the graduate school of education there. From 1961 to 1971 Seaborg headed the Atomic Energy Commission.

Stever's award came for "his scientific and engineering leadership in applying new results of scientific research and technological development to the purpose of government, industry and academe." His long record of public service began with his work on radar during World War II, first at MIT and then in London. From 1945 to 1965 he was a professor of aeronautics and astronautics at MIT, where his research topics included high-speed aerodynamics, shock-wave dynamics, hypersonic flow, rocket dynamics, aircraft and missile stability and control, and rocket and missile systems. In 1955–56 he was chief scientist of the US Air Force.

From 1965 to 1972 Stever was president of the Carnegie Institute of Technology, which merged with the Mellon Institute during his tenure to become Carnegie–Mellon University. He was director of the National Science Foundation from 1972 to 1976. From 1973 to 1977 he was science adviser to Presidents Nixon and Ford, and in 1976–77 he was also director of the White House Office of Science and Technology Policy. Since then he has been a director on the boards of several corporations, including TRW, Schering–Plough and Goodyear. He is also a trustee of several major research institutions, including the Woods Hole Oceanographic Institute, Science Service and Universities Research Association.

Stone was cited for his "outstanding leadership as project scientist for the Voyager space mission and its experiments in the outer solar system." He has been a principal investigator for nine NASA spacecraft missions, beginning with cosmic-ray experiments aboard the Discoverer satellites in 1961 and later including the Orbiting Geophysical Observatory, the Interplanetary Monitoring Platform, the International Sun–Earth Experiment and the High-Energy Astronomical Observatory. As project scientist at JPL for the Voyager missions, he worked on hardware development and mission operations and coordinated 11 scientific teams studying data from Voyager 1 and 2 at Jupiter, Saturn, Uranus and Neptune. He and his coworkers developed high-resolution instruments

Glenn T. Seaborg



H. Guyford Stever

Edward C. Stone

Steven Weinberg

to measure the isotopes and elements in energetic cosmic-ray nuclei and to study the magnetospheres of the outer planets and their satellites. These instruments detected the energetic sulfur and oxygen ions near Jupiter's volcanically active moon Io. Stone has helped develop a large-area instrument to measure from a satellite the abundance of rare, heavy Galactic cosmic-ray nuclei, and he has worked on the Gamma-Ray Imaging Payload, a balloon-borne gamma-ray telescope. He is also the principal investigator for the Advanced Composition Explorer, scheduled for launch in 1997, which will measure isotopic and elemental compositions of matter in space.

Stone earned his physics PhD from the University of Chicago in 1964. He then joined the faculty of Caltech, where he is a professor of physics. He was chairman of the physics, mathematics and astronomy division there from 1983 to 1988. He has been director of JPL since 1 January 1991. He is a member of the board of directors of the California Association for Research in Astronomy, the group responsible for building and planning the Keck Observatory in Hawaii.

James J. Duderstadt

Weinberg's citation lauded "his contribution to the discovery of the structure of the fundamental forces of nature, the development of the standard model and unification of the weak and electromagnetic forces." In 1967 Weinberg, and independently in 1968 Abdus Salam, developed a field theory that unified the electromagnetic and weak interactions as components of a single field. The theory, anticipated in part in earlier work of Sheldon Glashow, used an exact SU(2) $\times$ U(1) gauge symmetry that is spontaneously broken by the Higgs mechanism. The breaking of the symmetry results in electromagnetic interactions mediated by the massless photon and weak interactions mediated by the massive gauge bosons, $W^{\pm}$ and Z^0. Weinberg predicted the masses of the W and Z particles in terms of a weak mixing angle, θ_W, as well as the existence of weak neutral currents. The theory was proven in 1971 to be renormalizable; weak neutral currents were found in 1973; and the W and Z particles were discovered in 1983, confirming the essential elements of the theory, which is now called the standard model of electroweak interactions.

Weinberg has also worked in many areas of elementary-particle theory and cosmology and has helped plan the Superconducting Super Collider. He has written the textbook *Gravitation and Cosmology* and the books *The Discovery of Subatomic Particles* and *The First Three Minutes: A Modern View of the Origin of the Universe*, the last of which won a wide popular audience.

Weinberg received his PhD in physics from Princeton University in 1957. He worked at Columbia University for two years, then went to the University of California's Radiation Laboratory in Berkeley. In 1960 he became a physics professor at the University of California, Berkeley. From 1969 to 1973 he was on the faculty of MIT, after which he went to Harvard University. Since 1982 he has been a professor of physics and astronomy at the University of Texas, Austin. He shared the 1979 Nobel Prize in Physics with Glashow and Salam for work on the standard model.

In receiving the technology medal, Duderstadt was commended for "his excellence in the development and implementation of strategies for engineering education," as well as for "his successes in bringing women and minorities into the nation's technological work force." Duderstadt's research topics have included theory and design of nuclear reactors using both fission and fusion systems; neutron transport theory; kinetic theory and statistical mechanics; the interaction of laser beams with dense plasmas; high-power lasers; and computer simulation.

A physicist and engineer by training, Duderstadt got his PhD in physics from Caltech in 1967. For two years after that he worked at Caltech as a postdoc for the US Atomic Energy Commission. In 1969 he joined the faculty of the University of Michigan, where he is currently a professor of nuclear engineering. Duderstadt was dean of the college of engineering from 1981 to 1986, when he became provost and vice president of academic affairs at the university. He has been president of the university since 1988.

AAS DIVISION AWARDS GIVEN TO RESEARCHERS

Two divisions of the American Astronomical Society—the division on dynamical astronomy and the division for planetary sciences—have announced the 1991 recipients of several awards.

The division on dynamical astronomy has chosen Martin Schwarzschild of Princeton University to receive its 1991 Brouwer Award. Schwarzschild is cited for his "outstanding contributions in the field of dynamical astronomy applied to star clusters and galaxies" and also his role as "teacher and mentor, vice president of the IAU and president of the American Astronomical Society." Schwarzschild invented a simple numerical technique, now known as the Schwarzschild method, that has led to greater understanding of the equilibrium structure of elliptical galaxies.

Schwarzschild earned a PhD in astronomy from the University of Göttingen in 1935. After holding positions at the University of Oslo, Harvard and Columbia, he joined the Princeton faculty in 1947. He is currently the emeritus Higgins Professor of Astronomy there.

At the November meeting of the AAS division for planetary sciences, the Kuiper Prize was given to Edward Anders of the University of Chicago. Anders was cited for "his sustained and fundamental contributions to the understanding of the chemistry of the solar system, particularly the origin