in electrical engineering from Iowa State College in 1943. During World War II, he served in the US Navy and was stationed at the Naval Research Laboratory in Washington, DC. His work there involved putting connectors on cables, producing the wiring diagram for a captured Japanese fighter plane, and designing antennas.

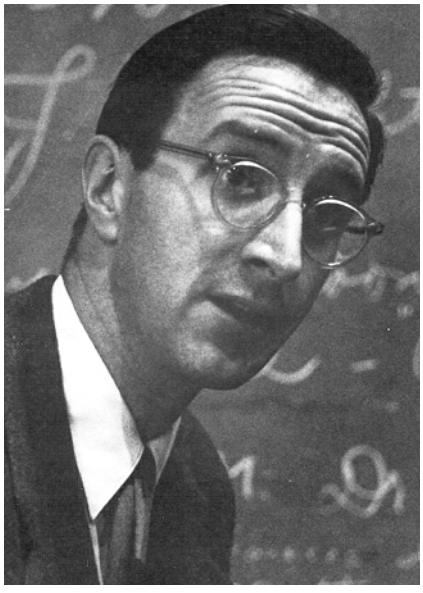
Following his wartime service, he enrolled in graduate studies in physics at the University of California, Berkeley, where he received MA and PhD degrees in 1948 and 1950, respectively. His thesis work under A. Carl Helmholz dealt with construction of a beta-ray spectrometer and its use in studies of nuclear beta decay.

At Berkeley, he met the experimental physicist Evans Vaughan, who became his wife in 1947. Toward the end of their studies, around 1950, Emilio Segrè told her that Ugo Fano (see PHYSICS TODAY, September 2001, page 73) of the National Bureau of Standards in Washington, DC, had an opening suitable for Ray to implement an experimental program in beta spectrometry at NBS. As a result of this exchange, both Ray and Evans obtained positions at NBS.

In 1950, Ray joined Fano's nuclear physics section at NBS (now known as the National Institute of Standards and Technology, or NIST) and began decay-scheme studies. Ray then moved to the radioactivity section under Wilfrid Mann and developed some of the first beta-gamma coincidence techniques for standardizing radionuclides used in nuclear medicine, such as iodine-131. In an article he wrote for *Advances in Electronics* in 1953, he gave a definitive description of the design and construction of beta-ray spectrometers.

In 1956, Ray became an adjunct professor of physics at the University of Maryland, College Park. When a separate nuclear spectrometry section was created at NBS during the mid-1960s, he was appointed its section chief.

Ray's activities led to his participation, in 1956, in the famous fundamental experiment that demonstrated that parity is not conserved in weak interactions. Chien-Shiung Wu (see PHYSICS TODAY, October 1997, page 120) at Columbia University contacted Ernest Ambler in NBS's cryogenic physics section, where one of us (Hudson) was chief, to suggest an experiment involving nonconservation of parity in the beta decay of cobalt-60 nuclei. Ray and his student Dale Hoppes helped design and construct the coincidence system. In 1962, Wu



RAYMOND WEBSTER HAYWARD

and the NBS team received the Franklin Institute's John Price Wetherill Medal for this work. The Department of Commerce bestowed its Gold Medal on the NBS team in 1957.

With assistance from students at Maryland and the Catholic University of America, Ray further investigated correlations among nuclear spin, beta particles and subsequent gamma rays, and probed other fundamental characteristics of beta decay. He spent the year 1961–62 in Copenhagen at the Institute for Theoretical Physics (now known as the Niels Bohr Institute) for the stimulating experience of joining the community of Niels Bohr, his associates, and a transient complement of some 50 distinguished visitors. There, Ray engaged in lively discussions of the problems that, at that time, were at the forefront of nuclear and elementary particle physics. Ray then returned to NBS.

For the next 20 years, Ray delved into various aspects of theoretical physics, including the long-standing difficult problem of the dynamics of fields with intrinsic spin greater than one. In a comprehensive study in 1976 (*NBS Monograph*, number 154), he used the variational methods of classical Lagrangian field theory to develop a relativistic theory of higher-spin fields. Beginning in the late 1970s and continuing through the rest of his career, Ray studied gravitational wave detection; he focused in particular on performing quantum nondemolition experiments and examined in detail the quantum properties of the macroscopic harmonic oscillator. He discussed how to measure certain observables of a harmonic oscillator, without affecting the results of subsequent measurements of the oscillator, to a precision better than the uncertainty imposed by the quantum limit.

After Ray retired from NBS in 1980, he continued to study electromagnetism, quantum mechanics, relativity, weak interactions, and gravitation.

Ray was a courtly, affable man with a wry sense of humor. His hobbies included mountain climbing, hunting, and fly-fishing. He also enjoyed listening to classical music and owned an impressive collection of recordings. The Haywards regularly entertained physicists from all over the world and were famous for the large parties they held when meetings of the American Physical Society were scheduled in Washington, DC.

RALPH HUDSON
Chevy Chase, Maryland
BERT COURSEY
National Institute of Standards and Technology
Gaithersburg, Maryland
SYDNEY MESHKOV
California Institute of Technology
Pasadena, California

Charles Thornton Murphy

Charles Thornton Murphy, who helped build Fermilab, died on 12 October 2001 of complications following a fall at his home in Batavia, Illinois.

C. Thornton Murphy, as he was commonly known, was born in Cambridge, Massachusetts, on 20 May 1938. The son of a classics professor, he traveled as a boy with his family throughout Europe. He eventually became fluent in Italian and French. In 1959, he graduated from Princeton University with a BA in physics. He earned an MS in 1961 and a PhD in 1964, both in physics, from the University of Wisconsin–Madison. His doctoral thesis, which addressed an experimental study of the branching ratios of the decay modes $\Sigma^{\pm} \rightarrow e^{\pm} + \nu +$ hadron(s), was prepared under the guidance of Jack Fry.

As a research associate at Wisconsin, he worked on bubble chamber physics at the Lawrence Berkeley Laboratory. He joined the University of Michigan as an assistant professor of physics in 1964, moving in 1968 to Carnegie Mellon University, where he developed several teaching innovations, including courses in relativity and new approaches to laboratory

CHARLES THORNTON MURPHY

classes.

On his arrival at Fermilab in 1972, Murphy inaugurated a bubble chamber program. He then shifted his research focus to the development of beams and experimental facilities. He was an important contributor to the design and construction of the proton laboratory, one of the three major experimental areas at that time. In 1977, he became the head of the proton laboratory.

Murphy headed the research division's beams group (1984–86), the cryogenic department (1986–88), and the research facilities department (1993–96). He played a key role in the Tevatron installation. An expert on the surveying requirements of large accelerator facilities, he consulted from 1991 to 1993 on the Superconducting Super Collider (SSC) project.

During his 28 years at Fermilab, Murphy continued the bubble chamber research he had begun at Michigan and Carnegie Mellon. He served as spokesman for the Fermilab bubble chamber experiment E-194, a study of proton interactions in deuterium. When that program was completed, he developed an interest in electronic experiments; that interest culminated in an extensive series of experiments on quark–antiquark and quark–gluon interactions that produced direct photons, muon pairs, charmonium states, and B mesons. The possibilities for using very-high-energy proton beams to produce large samples of B mesons led Murphy to combine his research and beams interests into an innovative proposal to extract a 20-TeV beam from the SSC using bent crystal channeling. In 1995, he then led a successful test of the process at the Tevatron. At the time of his death, Murphy was the manager of the Fermilab Switchyard 120 project that involved extracting the main-injector beam for fixed-target experiments.

Throughout his professional life, Murphy continued his interests in traveling and contacting scientists throughout the world. He developed an extensive network in Europe and Russia to support the SSC/Tevatron bent-crystal extraction test. He was a visiting scientist at CERN from 1985 to 1986, at the University of Hawaii at Manoa in 1991, and at the Frascati National Laboratories (LNF) in Italy from 1997 to 1998.

Murphy was fond of music. Only days before his accident, he led Fermilab in singing "Happy Birthday," in both Italian and English, to celebrate the 100th anniversary of Enrico Fermi's birth.

RICHARD CARRIGAN
Fermi National Accelerator Laboratory
Batavia, Illinois
BRADLEY COX
University of Virginia
Charlottesville
CRAIG MOORE
Fermi National Accelerator Laboratory
Batavia, Illinois

Frank Joseph Padden Jr

Frank Joseph Padden Jr, a leading figure in the polymer physics community, died on 21 January 2002. His car had been in a collision with a truck the previous day near his home in Mexico, New York. He suffered severe head injuries and died without regaining consciousness. He had served with great distinction for many years, both through his research contributions and by playing a very active role in the American Physical Society.

Padden was born in Scranton, Pennsylvania, on 21 September 1928. He earned his BS in physics at the University of Scranton in 1950 and then studied polymer rheology at the Mellon Institute of Industrial Research in Pittsburgh, Pennsylvania.

Following military service at Fort Detrick, Maryland, where he worked on classified research, he joined, in 1957, the American Viscose Corp in Marcus Hook, Pennsylvania. The company was then organizing a significant research effort on synthetic polymers, newly emerging as materials of much scientific and technological interest. He worked in close association with one of us (Keith) on the structure and morphology of semicrystalline polymers.

FRANK JOSEPH PADDEN JR

In 1960, Padden moved with Keith to Bell Telephone Laboratories in Murray Hill, New Jersey, where their collaboration continued for another 30 years. Padden and Keith's research has laid many foundations for understanding crystallization processes and their roles in controlling properties in such important materials as polyethylene, polypropylene, and nylons. APS recognized this work by jointly awarding them the High Polymer Physics Prize in 1973. Highlights of their work included the formulation of a phenomenological theory of spherulitic crystallization (1958–62), elucidation of deformation mechanisms in polymers (1959), visualization of important mechanical linkages between crystals in melt-crystallized polymers (1965–69), and studies (with Giovanni Giannoni and Bernard Lotz) of crystal growth and crystallography in synthetic polypeptides (model biological polymers; 1966–70). Padden retired from Bell Laboratories in 1993.

Padden was widely known and respected for his long and distinguished term of service (1967–88) as secretary–treasurer of APS's polymer physics division. He not only served as a link between the early pioneers who established the division and its current membership, but was also a guiding influence in strengthening and broadening its activities. This experience was especially valuable when he later served on the APS Council and its Executive Board. His effectiveness derived in large measure from a modest and self-effacing but very warm personality, backed by quiet wisdom