

the aerospace category for his development of M2P2, a mini-magnetospheric plasma propulsion system. In the communications category, **Aharon Agranat** was recognized for helping to develop Electroholography™, a method to interconnect electronic processors by holographic devices. He is the founder and director of Trellis Photonics, headquartered in Jerusalem, Israel, and holds the N. Jolla Chair of Applied Science at the Hebrew University of Jerusalem. **Joseph M. Jacobson** was honored in the electronics category for his innovation: printed inorganic chips. He is an associate professor at the MIT Media Laboratory. **Robert Wind** received the award in the health category for the development of the combined optical and magnetic resonance microscope. Wind is a staff scientist at the US Department of Energy's Pacific Northwest National Laboratory (PNNL) in Richland, Washington. At the same ceremony, the Christopher Columbus Fellowship Foundation presented the Christopher Columbus Foundation Award to **Richard A. Craig**, a staff scientist at PNNL, for developing the timed neutron detector. The foundation selected Craig from among the *Discover* awards nominees. The award has a cash prize of \$100 000.

This past June, **Erwin Frey** became a professor of theoretical physics at the Free University of Berlin and director of the theoretical physics department of the Hahn-Meitner Institute in Berlin. Frey, a theoretical biophysicist, was previously a Heisenberg fellow at both the Technical University of Munich and Harvard University.

The Japan Academy presented nine prizes, including one for physics-related work, this past June at a ceremony in Tokyo. A Japan Academy Prize went to physics researcher **Atsuhiko Nishida**, who supervises the Japan Society for the Promotion of Science and is an emeritus professor at the Institute of Space and Astronautical Science in Sagami-hara, Japan. Nishida received the award for his studies on Earth's magnetospheric structure and plasma convection.

In March, **Swapan Chattopadhyay** took his new post as associate director for accelerators with the Thomas Jefferson National Accelerator Facility (Jefferson Lab). He previously served as director of the Center for Beam Physics at Lawrence Berkeley National Laboratory and as a visiting professor of physics at the University of California, Berkeley.

physics with Enrico Persico, who had moved to the University of Turin. In 1934, after Ugo had completed his doctorate in physics at the University of Turin in 17 months, Persico arranged for him to join Fermi's group in Rome.

With scientific excitement and great humor, Fermi led the group to explore new directions and then challenge each new idea until it was demonstrably sound. Fermi would test ideas for himself, but saw that each of the younger scientists went through the same process. One story Ugo enjoyed telling concerns work on interpreting strange-seeming shapes of spectral absorption lines. Ugo worked several weeks on the problem, discussing it with Fermi as he progressed. One day he suggested an approach to Fermi, who, the next day, put his head into Ugo's office and said, "Fano, you were right." Weeks later, with a satisfactory solution, Ugo proposed a joint paper, but Fermi said, "No, the usual acknowledgment would be fine." Not long after the paper appeared under Ugo's name alone, Ugo peeked into Fermi's notebook and found that Fermi had worked out the solution—in precisely the notation that had appeared in the published paper—the same day he told Ugo he was right.

In 1935, while a lecturer at the University of Rome, Ugo visited Göttingen, Germany, and Copenhagen, Denmark, and met Arnold Sommerfeld, Niels Bohr, Edward Teller, George Gamow, and other established scientists. Two years later, he moved to Leipzig, Germany, to work with Werner Heisenberg. There he interpreted nuclear quadrupoles by modeling nuclei as aggregates of alpha particles, as Teller and John Wheeler did at about the same time. Then, a seminar in Rome by Pascual Jordan in 1938 stimulated his interest in radiation biology and genetics, which would become central topics for his later research.

In 1935, Ugo left Italy, where the ethnic laws had made it impossible for him to work. First he went to Paris, where he collaborated with Pierre Joliot. Then he arrived in the US in 1939. He became a guest researcher at the Carnegie Institution of Washington (CIW). He received his first research position at CIW at Cold Spring Harbor in New York, but World War II intervened, so he began work on ballistics at the US Army's Aberdeen Proving Ground in Aberdeen, Maryland.

After the war, he returned to CIW

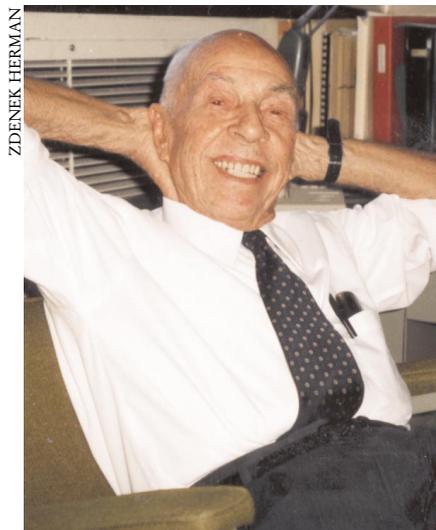
## OBITUARIES

### Ugo Fano

Ugo Fano, professor emeritus of physics at the University of Chicago and a leader in theoretical atomic physics, died in Chicago on 13 February 2001 of complications from Alzheimer's disease.

Born in Turin, Italy, on 28 July 1912, Ugo was the son of a mathematics professor. He grew up in Turin and Villa Fano, near Verona, an estate that his grandfather acquired and the family continues to enjoy. The atmosphere of his childhood was intensely intellectual. Being somewhat sickly, he was tutored until he entered the fourth grade. From the time he received his first bicycle at age 12, he developed a love for the outdoors and for mountains—first hiking and then rock climbing, especially in the Dolomites.

While hiking in the summer of 1924, Ugo's father exchanged a few words with a group of young scientists from Rome. He later told Ugo that one of those scientists would go far—a



ZDENEK HERMAN

UGO FANO

man named Enrico Fermi, who would eventually become Ugo's mentor.

Ugo's school friends included Salvatore Luria. Ugo's older cousin Giulio Racah persuaded Ugo to study

at Cold Spring Harbor, but actually spent much time at the physics department of Columbia University, where he started his exploration of the effects of radiation on matter. At Cold Spring Harbor, Ugo studied the biological effects of radiation on living organisms. During his early work with *Drosophila* and genetic resistance to radiation effects, and his later work at the National Bureau of Standards (NBS), he set himself to the task of sorting out the complex array of processes that radiation could induce in living systems.

In 1946, Ugo joined the group of Lauriston Taylor at the NBS, where he elucidated fundamental physical processes. He worked closely with experimentalists such as Robert Madden and Keith Codling to use synchrotron radiation to study spectra in regions previously almost inaccessible, and then, with theorists around him, to interpret those results. One notable example concerned the excitation of quasi-bound states buried in continua, whose spectra, with their Fano line shapes, imply much about the nature of electron correlation.

In 1966, with the NBS's impending move to Gaithersburg, Maryland, Ugo's old friend Robert Platzman and the chair of the University of Chicago physics department, Mark Inghram, persuaded him to join the physics faculty at Chicago. There, Ugo developed a lively group of graduate students and postdoctoral associates, many of whom are now spread throughout academia, government, and industry, continuing research in the tradition they learned from him. Ugo continued, uninterrupted, his research on the interaction of radiation and matter well past his retirement in 1982 and into the late 1990s.

Ugo was always very matter-of-fact, questioning every new scientific hypothesis and model with a candor characteristic of a true scholar. He emphasized the importance of working on problems that appeared solvable in the sense of finding an effective way to connect what one knew with something yet to be found. He was skeptical of efforts to solve "fundamental" or what he considered "philosophical" problems in physics, not because he thought these were unimportant. On the contrary, he thought that current theory could only be a partial, incomplete description of physics. In his humility, he believed that people capable of truly contributing to those problems are so rare that nobody he knew should

bother to try.

Ugo received the Enrico Fermi Award from the US Department of Energy in 1995. The special issue of *Physics Essays* (June and September 2000) honors Ugo. It contains his curriculum vitae, a bibliography, a biographical essay, and 40 articles on recent developments in topics he studied. The issue also carries his last article, "Memories of an Atomic Physicist: For My Children and Grandchildren."

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## Minoru Oda

Minoru Oda, the founder of space astronomy in Japan and a key participant in the exploratory work in the US that initiated the field of x-ray astronomy, died in Tokyo on 1 March 2001 from complications following surgery.

Oda was born on 24 February 1923 in Sapporo, Japan, the elder son of a distinguished physician. After earning a BS degree in physics at Osaka Imperial University (now Osaka University) in 1944, he was recruited to the Japan Naval Research Laboratory's Shimada branch, established by Prince Takamatsu in a remote location to shield scientists from the war. Many years later, Oda recounted that microwave research at Shimada achieved a beam strong enough to cook rice or even kill a dog at some distance. More important, many of the Shimada scientists became leaders in the postwar development of science in Japan and around the world.

As a graduate student in 1947, Oda's interest was drawn to the possibilities of radio astronomy by his supervisor, Yuzuru Watase. Oda and Tatsuo Takakura built a 3.3-GHz radio telescope with which they observed solar radio emissions, the first radio astronomy observations in Japan. In 1950, Oda was appointed assistant professor of physics at Osaka City University. Three years later, he came to MIT as a visitor to the cosmic-ray group of Bruno Rossi. Oda helped set up the first of the large extensive cosmic-ray air shower experiments carried out by the Rossi group with their new methods of density sampling and fast timing. Thus began a lifelong friendship between Oda and Rossi, two of the most influential scientists in the development of

cosmic-ray and space physics.

On his return to Japan in 1956, Oda received his doctorate in physics from Osaka Imperial University. That same year, he was appointed an associate professor of physics at Tokyo University's Institute for Nuclear Studies (INS). At INS, Oda initiated cosmic-ray studies, among which was the Bolivian Air Shower Joint Experiment (BASJE). Inspired by the theoretical work of Satio Hayakawa, the BASJE was designed to detect extensive air showers of low muon content initiated by primary gamma rays produced in interactions of cosmic-ray nuclei with interstellar matter. Koichi Suga came to MIT from INS to build the equipment that was set up at 17 000 feet on Mount Chacaltaya in Bolivia under the direction of Ismael Escobar. The experiment detected showers with the expected low proportions of muons at an occurrence rate consistent with predictions, but did not yield certain evidence of a predominantly gamma-ray origin.

Oda returned to MIT in 1962, intending to work on BASJE data. His interest was diverted by the discovery of the first extrasolar x-ray source, Sco X-1, in a rocket experiment initiated at the urging of Rossi and carried out by Riccardo Giacconi and his associates at American Science & Engineering Inc (AS&E). Recognizing the importance of higher angular resolutions in x-ray observations than could be obtained with conventional collimators, in 1965 Oda invented the modulation collimator, a device of two or more layers of parallel wires and the forerunner of the various transform collimators that have since been used in x-ray and gamma-ray observations where imaging by reflection is not feasible.

In 1966, a joint AS&E-MIT rocket experiment with modulation collimators determined the position of Sco X-1 within a few arc minutes, which enabled scientists to identify the optical counterpart as a rapidly fluctuating 13th-magnitude blue star in observations at the Tokyo and Palomar observatories. The discovery and optical identification of Sco X-1 were the sparks that ignited the field of x-ray astronomy.

That same year, Oda was appointed a professor of physics at the newly formed Institute of Space and Aeronautical Science (ISAS) at Tokyo University. Under his leadership, ISAS launched a series of increasingly sophisticated satellite observatories, several with instruments developed in collaborations with US and European