

obituaries

Scott Ellsworth Forbush

Scott E. Forbush, a world-renowned pioneer in the study of cosmic-ray intensity variations, died on 4 April 1984, on the eve of his eightieth birthday. He had been a staff member of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington for 43 years prior to his retirement in 1969.

Originally engaged in geomagnetic research, he worked in the field at stations such as Huancayo, Peru, and the non-magnetic ship "Carnegie." In 1932, at the request of Arthur H. Compton and Robert A. Millikan, the Carnegie Institution undertook to establish a worldwide network of ionization chambers for continuously recording cosmic rays, using the existing geomagnetic observatories for the jointly designed Compton-Bennett meters. Forbush was chosen to head the project. By mid-1935, Compton and his colleagues at the University of Chicago had built and tested seven meters. By the end of 1938, five of these had been permanently installed and continuous registration had begun: at Cheltenham Magnetic Observatory, Maryland; Huancayo Magnetic Observatory Peru; National Astronomical Observatory in Teolayucan, Mexico; Christchurch Magnetic Observatory, New Zealand; and Godhavn Magnetic Observatory, Greenland. The two remaining meters were used mainly for special investigations, such as latitude surveys in the Atlantic and Pacific. They were later installed at the University of Puerto Rico and at Climax, Colorado.

Forbush's keen analytical insights, and his proclivity for devising and using statistical techniques that were appropriate for testing the reliability of results deduced from geophysical measurements, enabled him both to discover new phenomena arising from cosmic-ray modulations and anisotropies and to provide, where needed, a sound statistical basis for the controversial results of others. The cosmic-ray time variations he studied ranged from minutes to decades; his most recent finding, upon which he worked assiduously after his retirement, was a variation in the diurnal anisotropy with a period of one solar magnetic cycle (approximately 22 years). Forbush discovered or legitimized every known time variation of cosmic rays that the data from his first-generation instruments were capable of resolving. In 1937, he first detected the worldwide decrease in the cosmic-ray flux that occurs after major solar flares; the Forbush Decrease is still the subject of intensive study.



FORBUSH

Forbush had exceedingly high standards and eschewed sloppiness, especially with respect to the statistical treatment of data. In his last publication, reporting upon work carried out with his long-time collaborators at the Bartol Research Foundation, he finally solved the long-standing problem of how to test rigorously the statistical significance of results obtained by Chree analysis.

Forbush was a graduate of the Case Institute. During World War II, he headed a mathematical analysis section of the Naval Ordnance Laboratory. He also served as chairman of the Cosmic Ray Panel of the US Committee for the International Geophysical Year. He was elected to the National Academy of Sciences in 1962, and was a fellow of APS, AAAS and AGU.

Scott Forbush was a unique individual whose place in the annals of cosmic-ray research will endure. He was held in tremendous respect by his colleagues, and was dearly loved by his friends, all of whom were indeed fortunate to have enjoyed the privilege of being associated with a person of his caliber.

MARTIN A. POMERANTZ
Bartol Research Foundation of
The Franklin Institute

Giuseppe Colombo

Giuseppe Colombo, a scientist at the Harvard-Smithsonian Center for Astrophysics and an internationally known expert in space sciences and mechanics, died of cancer in Padua, Italy, 20 February 1984. He was 63 years old.

Colombo was professor of spacecraft and space structures at the University

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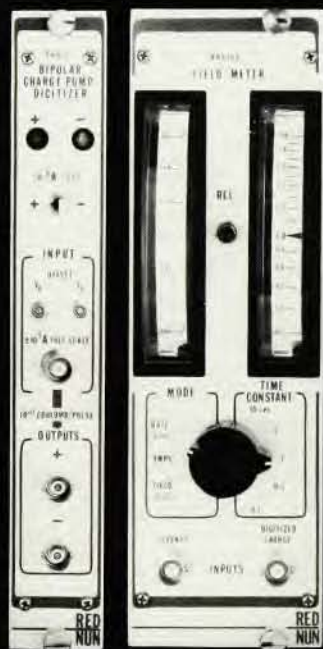
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of Padua and professor of celestial mechanics at the Scuola Normale Superiore in Pisa. He directed an institute in applied mechanics in Padua and was also a consultant to both the Italian government and the European Space Agency; for many years, he served in a similar capacity at NASA's Jet Propulsion Laboratory.

A native of Padua, he graduated from the University of Pisa in 1943, and, after receiving his PhD in applied mathematics at Padua, he held a succession of academic posts at various universities throughout Italy.

Colombo's early research in nonlinear mechanics gained him international recognition and led, in 1961, to his appointment to the Smithsonian Astrophysical Observatory and, in 1962, to the Harvard College Observatory. Later, he was the Jerome Clark Hunsaker Visiting Professor of Aeronautics and Astronautics at MIT (1980) and the Sherman Fairchild Distinguished Scholar at Caltech (1982).

For nearly a quarter century—indeed, until just a few months before his death—Colombo shuttled regularly between Padua and Cambridge, Pasadena and various other cities in the United States and Europe, where he dispensed advice, wise counsel, and ideas from his apparently unlimited imagination. These usually centered on unlocking the secrets of the solar system and creating spacecraft and space structures to explore it. In 1965, for example, he suggested that Mercury's rotation was in a unique resonance with its orbit, spinning exactly three times on its axis during every two orbital periods. Some years later, while attending a NASA briefing on the Mariner 10 mission, he did a traditional "back of the envelope" calculation showing that the Mariner 10 spacecraft could easily be boosted into an orbit that would bring it back for second and third bonus looks at Mercury, six months apart. These multiple encounters provided, for example, unequivocal evidence that Mercury has an internally-generated magnetic field, contrary to virtually everyone's expectation.

In his heavily accented English, "Bepi," as he was known to his friends here and abroad, would passionately describe new imaginative schemes on each visit on his tour. He held many patents, including one for a new type of "dumbbell" gravity gradiometer. At MIT in 1981, he and his students devised an unusual scheme for delivering large payloads into space orbit, a technique akin to a speeding railroad train snatching up a mail sack. In recent years he devoted much attention to the "skyhook" concept developed in collaboration with Mario Grossi at the Smithsonian Astrophysical Observa-



COLOMBO

tory. This idea led to many proposals for applications for tethers extending up to 100 km from satellites in low Earth orbit.

Even while in the hospital in Italy, Colombo remained in telephone contact with several of his colleagues at the Smithsonian who were developing these ideas with him, including studies of the Earth's upper atmosphere and magnetosphere and of the potential for "skyhook" tethers to generate electric power while knifing through the Earth's magnetic field.

Colombo's contributions were recognized by awards and honors in Europe and the United States. He received Italy's National Award for Astronomy and Geophysics and was elected to the Pontifical Academy of Science; in this country, he received NASA's Gold Medal for Outstanding Scientific Achievement and was a fellow of the American Academy of Arts and Sciences.

Colombo was not only an exciting colleague, but also a loyal friend. It is hard for us to accept a world without him.

GEORGE FIELD

IRWIN SHAPIRO

Harvard-Smithsonian Center for
Astrophysics

Nathaniel H. Frank

Nathaniel H. Frank, professor emeritus of physics at MIT, died of a heart attack 19 February 1984. Born in Boston on 18 March, 1903, he was active at MIT from 1919 till his death. He was a student there; then for the last 60 years, he spent his energies and his human sympathies in the teaching of physics. His undergraduate texts are by now classics, and the book on theoretical physics he wrote with John Slater has been standard for many senior courses in the subject. After his "retirement" in 1968, he was active in