

the corresponding neutrino form an isotopic doublet and that the weak interaction is isotopically invariant.

The effects of parity violation in atomic transitions proposed by Zeldovich for heavy elements were experimentally demonstrated only two decades later, accompanied by strong disputes in several groups of experimenters. His contribution to the confirmation of the standard model of electroweak interactions appears absolutely doubtless.

Meanwhile quite different distance scales caught his attention. The 1960s witnessed the beginning of his work in astrophysics and cosmology, which brought him worldwide recognition in the 1970s and 1980s.

Zel'dovich possessed a literary talent of remarkable force. It revealed itself with brilliance and power not only in his scientific books and reviews, but also in memoirs, comic essays, plays and poems permeated with his rare sense of humor.

I hope someday to bring to readers of popular scientific journals the rich collection of the letters, notes and sketches he used to drop into my letter box during the decades our apartment doors were next to each other, as well as the comic play that we wrote and staged together in 1946 on the 50th anniversary of our teacher Semenov.

His many friends find it hard to realize that he is no longer with us; we will never have enough time to get used to the thought. I would like to add that the members of the large and united Zel'dovich family have always lived for each other, and for physics. The talents of his children and their achievements were objects of pride and joy for our dear late friend, and consoled him in the unavoidable cloudy hours of his life.

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(Editor's note: A discussion of Zel'dovich's work in astrophysics will appear in a later issue of PHYSICS TODAY.)

James Barcus

James Roy Barcus, professor of physics at the University of Denver, died 3 January 1988 at his home in Denver after a long battle with lung cancer.

Jim was born in Kansas City, Missouri on 30 September 1930. He served in the US Navy before enrolling as an undergraduate at the University of New Mexico, where he

obtained both his BA and his PhD. His doctoral research under John R. Green was on extensive air showers of cosmic radiation. In 1961, following graduate school, Jim became a research scientist at the University of California, Berkeley.

Jim came to Berkeley at a time when the use of high-altitude balloons to measure auroral x rays in the polar regions was still in its infancy. He played a leading role in organizing and carrying out electron precipitation studies with simultaneous measurements from magnetically conjugate regions in the Northern and Southern Hemispheres. Also while at Berkeley, Barcus pioneered the combined use of balloon-borne photometric and x-ray detectors in auroral studies. In addition, he obtained the first information about the spatial features of electron microbursts, through the use of multiple, spatially separated balloon flights.

He joined the University of Denver in 1965, and became a full professor there in 1970. He continued with conjugate studies and began balloon flights in Antarctica during his early Denver years.

In 1974 Jim began an active and fruitful interest in using sounding rockets to study the response of the middle atmosphere to various high-energy inputs such as auroral x rays produced by bremsstrahlung and relativistic electrons, and in middle-atmospheric electrodynamics. This work involved collaboration with a large number of scientists at various US and foreign institutes and universities. The more notable programs in which he participated included Antarqui and Condor in Peru; Aurorzone I and II in Alaska; Middle Atmosphere Electrodynamics I, II and III, conducted in Norway and Alaska; and, most recently, MAC/Epsilon, carried out in Norway in October 1987. His important contributions include the discovery of relativistic electron showers associated with most, and perhaps all, auroral events, and the discovery of micropulsations in relativistic electron showers, which he also observed in Norway in 1980. The latter phenomenon eventually became the PhD thesis topic of his graduate student Karl Hudnut. Barcus also contributed to studies of the effects of the x-ray star Sco X-1 on the middle atmosphere, anomalously large electric fields in the mesosphere, the influence of very low frequency electromagnetic waves produced by manmade transmitters and lightning on magnetospheric electron precipitation and, most recently, neutral atmospheric-wave-in-

duced turbulence in the mesosphere. His spirit and drive helped him maintain a keen and productive interest in his research nearly up to the time of his passing.

Barcus also served as a program director of the Solar-Terrestrial Program at the National Science Foundation, and he was a member of the scientific committee on Antarctic research. He had excellent skills as an experimenter and was particularly adept at instrument and electronics development. His enthusiasm for experimental work was infectious, particularly under the often difficult and demanding circumstances of field work.

Barcus had a clear insight into the physics underlying his experimental observations. He enjoyed discussing the salient features of the data he collected from balloon expeditions with colleagues from various research specialties, and they in turn sought his criticism and advice. He mixed easily with colleagues from many countries and cultures.

He enjoyed teaching undergraduate classes, where he always insisted that his students think for themselves. His students always responded by doing more than the minimum required to pass, and many returned to see him after several years, to thank him for challenging them. His colleagues and students from many countries will miss him.

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James Wittke

James P. Wittke died unexpectedly on 31 October 1987. A universally respected physicist, he was known for his keen analytical abilities, the breadth of his interests, and his willingness and ability to deal with any problem. Jim's contributions extended from quantum mechanics to optical communications to manufacturing technology; his interest in gardening, for instance, led him to develop computer programs to analyze the effects of temperature and rainfall on his own garden. Jim spent his entire professional career, after one year as an instructor at Princeton Universi-