Jules Aarons (1921–2008)

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Jules Aarons, a pioneer in satellite radio beacon studies of the ionosphere, died peacefully at his home in Newton, Mass., on 21 November 2008 at age 87. When considering his college career, Jules was drawn toward the humanities, an interest subsequently redirected by his parents toward science as a more suitable way to earn a living, and then by the U.S. Army Air Corps toward radio technology as a more suitable way to win World War II. Both goals were readily accomplished, perhaps instilling in Jules the value of proper mentorship, that central aspect of his life that so dominates our recollections of him.

After the war, and with a variety of options before him, Jules decided upon civilian government service at the U.S. Air Force's then new field station in Cambridge, Mass. This was the founding entity of the Air Force Cambridge Research Laboratory (AFCRL), and those five famous letters became identified with his professional career (1946–1981). With Russia's launch of Sputnik in 1957, the era of space-based radio communications began, and with it the need to understand the sporadic crackling and fading ("scintillations") of radio transmissions from satellites to ground receiving stations. Wartime efforts also gave birth to radio astronomy. Jules fostered ways to fund the synergies he saw between the radio technologies of space science and those of ground-based radio astronomy in ways almost unimaginable today (and certainly not by former U.S. senator Mike Mansfield, whose 1973 amendment to the U.S. Congress's defense appropriations bill limited the financing of basic research by military agencies only to projects that have direct military consequences; the amendment resulted in a permanent restructuring of how U.S. Department of Defense (DOD) agencies fund university-based research).

Under Jules's leadership, AFCRL's Radio Astronomy Branch observed signals from radio stars, pulsars, and satellites as ways to probe the scale sizes, spatial patterns, and temporal variability of the ionospheric irregularities that cause scintillations. As DOD needs for reliable radio communications grew to encompass diverse parts of the globe, Jules realized that the quality of radio reception depended far more on the geographical locations of the receivers than on any intrinsic variability of the radio sources. Since the severity of a radio disruption was linked to the degree of solar and geomagnetic activity, Jules and his colleagues embarked upon a program of solar geophysical research focused on Defense Department applications but also broad in scope and steeped in basic science. Indeed, with John Castelli and colleagues, solar radio astronomy grew to become a major program supported by the Air Force. With Jack Klobuchar and colleagues, the study of total electron content (TEC) became an additional priority, and especially so when it was realized that TEC's impacts upon transionospheric radio wave time delays would be crucial to the DOD's vision of a global positioning system (GPS) for satellite-based navigation and geolocation.

As an individual scientist, Jules Aarons's legacy rests securely in the specification of the global patterns of ionospheric irregularities. While at AFCRL, he defined a "scintillation boundary" that marked the transition from the serene midlatitude ionosphere to the turbulent auroral and polar cap plasma environments. When DOD interests turned to equatorial and low latitudes, Jules again defined the spatial and temporal patterns of scintillation activity. In later years, he made the crucial step in our understanding of how low-latitude irregularities (equatorial spread *F*) can be both instigated and suppressed during the different phases of geomagnetic storms, an advance known today as the "Aarons criteria."

Promoting a Global Perspective

As a branch chief and senior scientist at AFCRL, Jules envisioned and then created with his laboratory colleagues a global network of observatories to monitor the Sun continuously and the ionosphere in diverse geophysical regions. In addition to funding programs at U.S. universities, he fostered programs in Europe, Asia, South America, and Africa, providing in almost every case the only access to high-quality research equipment for university research groups in developing countries. He nurtured programs that never would have grown with only national support. At the individual level, Jules also provided funding for participants to attend data review meetings that he viewed as critical for the professional development of the many young scientists

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working under AFCRL auspices. He literally created and maintained professional careers throughout the world. Today, his vision and guidance of government-sponsored research abroad would probably result in his arrest under provisions of the International Traffic in Arms Regulations (ITAR), which essentially ban all international collaborations in space-based science unless special exemptions are received from the U.S. State Department.

Jules's formal education in physics, as with his keen knowledge of cuisine, spanned a spectrum from local to regional to international. His B.S. from City College of New York (CCNY) in 1942 was followed by a period of military-sponsored education in radio techniques at several U.S. universities. After World War II, Jules earned his M.S. at Boston University (1949), and his Ph.D. from the University of Paris (1954) as a Fulbright Scholar.

New Horizons

Upon retirement from Air Force service in 1981, Jules returned to Boston University as a research professor of astronomy and space science for the next 25-year phase of his science career. His research productivity and gentle advice to students, staff, and faculty had an impact that endures. Jules's professional recognitions include being named a Fellow of the Institute of Electrical and Electronics Engineers (IEEE) in 1975, chairman of the Electromagnetic Propagation Panel of the NATO Advisory Group for Aerospace Research and Development (1979–1981), and chairman of the Commission on Ionospheric Radio Wave Propagation of the International Union of Radio Science (URSI) from 1980 to 1983. Jules delivered the prestigious Appleton Lecture at the Institution of Electrical Engineers, in London, in 1995. He was a frequent and active participant in AGU meetings throughout his career.

Unknown to most of Jules's science colleagues was his second professional career, as a documentary photographer. As a photographer, Jules Aarons is known worldwide for his technique of taking nonintrusive images in public places of people unaware of his presence. As an undergraduate at CCNY, Jules began his photographic experiments using this approach, and he perfected it in Boston's diverse neighborhoods and throughout New England while at AFCRL. Many other remarkable pictures were taken while Jules was on professional travel abroad.

Solo exhibitions of Jules's photographs span the years 1949–2007, and his images are in a number of permanent collections including the Museum of Modern Art (New York), Bibliothèque Nationale and Bibliothèque Historique de la Ville (both in Paris), Museum of Fine Arts (Boston), Boston Public Library, DeCordova Museum and Sculpture Park (Lincoln, Mass.), The Boston Society, and the Museum of Art, Rhode Island School of Design, in Providence. Six catalogs of his photographs appeared between 1964 and 2004. The most recent (2006) book of images and essays is *Public Spaces/Private Moments: The Photographs of Jules Aarons*, published in 2006 and available from the Gallery Kayafas (http://www.gallerykayafas.com/), Boston. Another Web site, http://www.buimaging.com/aarons, also has images by Jules.

Jules leaves two sons, Herbert and Phillip, and their families. He was predeceased by his wife, Jeanette. He will be remembered by friends and colleagues worldwide for his observational talents, both geophysical and photographic, and for his kindness, consideration, and deep interests in our lives and careers.

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