Professor Emeritus Bernard Burke, astrophysics pioneer, dies at 90

Former Astrophysics Division chair discovered radio noise from Jupiter and the first Einstein Ring, and developed tools to map the universe.

by Sandi Miller for the Department of Physics

Bernard F. "Bernie" Burke '50, PhD '53, the William A.M. Burden Professor of Astrophysics Emeritus and a principal investigator at the MIT Kavli Institute for Astrophysics and Space Research, was an innovator whose research into radio astronomy stretched our view into the farthest reaches of the universe. He passed away on August 5, 2018, at age 90.

A former chair of the Department of Physics' Astrophysics Division, Burke's most notable achievements included the discovery of decametric radio noise from Jupiter—for which he earned the 1963 Helen B. Warner Prize of the American Astronomical Society—and the first Einstein Ring, the deformation of light in the form of a ring around a massive cosmic object due to gravitational lensing. He played a key role in developing very long baseline interferometry (VLBI), which allows high-resolution imaging of cosmic structures, and the Very Large Array (VLA) radio telescope, to aid in his research of gravitational lenses, quasars and galaxies. Burke is the co-author, along with Francis Graham-Smith, of *Introduction to Radio Astronomy*, now in its 3rd edition.

"Those of us who have been here a while remember many decades of his humor, energy, intellect, and zest for life," says Jacqueline Hewitt, former director of the MIT Kavli Institute and one of 19 students mentored by Burke. "This is a great personal loss for me, and I know many at MKI who were close to him share my sorrow."

A longtime resident of Cambridge, MA, Bernard Flood Burke was born in Brighton, MA, on June 7, 1928. His father Vincent was head of the math department at Rindge Technical High School. His mother Clare was a statistical typist who devised her own method to manually type complex math formulas. When he was young, he would sit for hours doing math problems.

At 16, he and a high school friend purchased a large piece of glass to grind it into a telescope's lens. "They enjoyed the challenge involved to shape it and grind it correctly," says his sister, Sally Berenson.

After graduating from Lexington High School, he turned down a major conservatory's full scholarship to study the violin, and chose instead to study at MIT. With the Cold War then starting, he joined the ROTC's Signal Corps, where he learned Russian, worked under a decryption specialist, and was promoted to first lieutenant. He also worked on Project Hartwell, a U.S. Navy-MIT collaboration that researched long-range underwater acoustic detection sensors for anti-submarine warfare.

Burke received his PhD in 1953, studying physics and astrophysics, with a focus on microwave spectroscopy, and joined the Carnegie Institution of Washington's Department of Terrestrial Magnetism (DTM) as a radio astronomer. There, he designed and constructed radio interferometers, radiometers and radio telescopes.

In 1955, he and his colleague Kenneth Franklin set out to map the northern sky using a radio antenna array, with receivers in the rural 96-acre Mills Cross field, near Washington. One night they heard a hissing sound they thought was from a passing vehicle. But when they tested the array and moved it in a southern direction, they detected bursts of radio radiation and realized that they had actually been listening to Jupiter. This was the first detection of non-thermal radio noise from a planet, and led to a new way of exploring the Solar System. The discovery earned Burke the Warner Prize.

Burke's other achievements at DTM included directing the instrumentation of its 60-foot radio telescope; conducting studies of 21-cm line hydrogen radiation from the Milky Way Galaxy; transporting a multichannel receiver to a 300-foot radio telescope at the National Radio Astronomy Observatory (NRAO) at Cornell University; studying the velocity disruption of interstellar hydrogen in the Andromeda Galaxy; and helping discover tidal distortion of the galaxy. Burke served as chair of DTM's Radio Astronomy Section from 1962 to 1965. Later, he was a member of DTM's visiting committee in 1994 and its first Merle A. Tuve Senior Fellow in 1997.

Back to MIT

In 1965, he joined MIT as a professor of physics with tenure, and as a member of the Research Laboratory of Electronics. He served as chair of the Astrophysics Division from 1970 to 1983, and was named the William A.M. Burden Professor of Astrophysics in 1981. "One of his defining characteristics was his huge level of energy and enthusiasm, and his focus on science," said Claude Canizares, the Bruno B. Rossi Professor of Physics and associate director of the Chandra X-ray Observatory Center.

Burke joined Professor Alan Barrett in the study of hydroxyl masers using telescopes at Millstone, Haystack Radio Observatory, and the Harvard Observatory. He directed the effort to link these telescopes to be used as interferometers. Burke showed that the angular sizes of the OH sources were so small that they could not be thermally excited and had to be naturally occurring masers. In 1967, this interferometry work led to the development of VLBI, in a joint effort with NRAO and Canada's National Research Council. VLBI used atomic frequency standards to synchronize pairs of radio telescopes around the world to study quasars and hydroxyl-line emitters with an angular resolution 1,000 times better than previous methods. For this achievement, the American Academy of Arts and Sciences awarded Burke and the other participants the Rumford Prize in 1971.

In 1967 his MIT group was the first to conduct intercontinental VLBI, and in 1970 the first to extend the technique to the 1.35-cm water vapor line, showing that water emission, like hydroxyl emission, came from what he called "extraordinarily energetic and compact sources." Burke led the first Russian-U.S. VLBI experiment to measure the angular size of H_2O masers, in 1971. Jim Moran, the Donald H. Menzel Professor of Astrophysics Emeritus at Harvard University, recalled conspiring with Burke to carry a live atomic clock on a flight from Paris to Moscow. "This was necessary in the Cold War days, and long before the GPS era, in order to synchronize the station clock at the telescope in Russia with its counterpart at the U.S. telescope to an accuracy of better than a microsecond," Moran recalls. "It was a real swashbuckling adventure."

In 1970, Burke began a campaign to extend VLBI methods into space. He was a major participant in the first three successful VLBI space missions where orbiting radio telescopes operated with arrays of telescopes on the ground to produce images of radio sources of unprecedented resolution: the connection of the TDRSS satellite into a ground-based network in the late 1980s; the Japanese-led VSOP/Halca project launched in 1997; and the Russian-led RadioAstron project launched in 2011 and still operating.

Burke participated in an MIT group that helped develop the Very Large Array (VLA), at the time the largest, most expensive ground-based astronomical instrument ever built when it was completed in 1980. He used the VLA to study gravitational lenses.

Einstein's theory of general relativity predicted that massive objects could bend light rays passing nearby. The first example of this gravitational lensing effect outside the solar system was found in 1979, when Burke made this a major focus of his research. His team used the VLA to measure the time delay between components of the first known lensing object, 0957+561, to estimate the value of the Hubble Constant, which characterizes the age of the universe. Einstein suggested that if a bright object were positioned precisely behind a massive body, then a perfectly symmetric form of lensing would be produced; however, he predicted that such an event would be highly unlikely. Nonetheless, Burke, Hewitt, and others discovered this effect in 1988, which is now referred to by scientists as an "Einstein ring." Teaming up with scientists from Princeton University and Caltech, they conducted a huge search for additional Einstein rings with the VLA and created an archive of more than 400 maps from the survey. At the NRAO, he led a series of MIT-Green Bank 5-GHz surveys that compiled thousands of radio sources in the sky using the 300-foot Green Bank telescope in West Virginia and detected gravitational lenses.

As a professor, Burke challenged his students on and off campus before retiring in the mid-1990s. "Bernie was my PhD advisor, and he taught me many things," recalls Hewitt. "Radio astronomy of course, but also sort of how to sail (we did capsize on occasion), and most importantly his superlatively positive approach to life I believe rubbed off on me a bit."

As a member of the National Academy of Science and several of its committees, Burke guided National Science Foundation and NASA funding for the astrophysics community. He was appointed to the National Science Board by President George H.W. Bush and continued to serve under President Barack Obama, and participated on a NASA committee that reviewed the history and future of space travel. At NASA, he was chair of the Toward Other Planetary Systems Science Working Group, and was a member on its Astronomy Missions Board, Physical Sciences Committee, and the Space Science Advisory Committee.

Princeton Astrophysics Professor Neta A. Bahcall calls him "one of the giants of astrophysics"—a pioneering radio astronomer whose research has extended over many topics. "The astronomical community lost a star," says Bahcall, though his work lives on. "His scientific legacy will continue to shine."

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