

# MEMORIAL RESOLUTION

## RONALD N. BRACEWELL

(1921-2007)

Ronald Newbold Bracewell, Lewis M. Terman Professor Emeritus of Electrical Engineering, died of a heart attack at his home on the Stanford campus on August 12, 2007 at the age of 86. Widely recognized as a pioneering radio astronomer he also made innumerable contributions to the field of electrical engineering and medical imaging. Indeed, later in his career at Stanford, he took great pleasure in acquainting his colleagues in the Electrical Engineering Department with the many ways in which astronomy and planetary science contributed to progress in electrical engineering.

Ron was born in Sydney, Australia, on July 22, 1921, and attended school at the Wiley Park Junior School and the Sydney Boy's High School. He graduated from the University of Sydney in 1941, with a degree in mathematics and physics. Since World War II was in progress he became involved in the development of microwave radar in the Radiophysics Laboratory of the Council for Scientific and Industrial Research (CSIR), which was the national organization for scientific research in Australia at the time. This radar work led to his interest in radio astronomy immediately after the war, when he became a graduate student in the Cavendish Laboratory of the University of Cambridge. After earning his Ph.D. in physics, he joined the Stanford faculty in 1955, where he ultimately held the Lewis M. Terman professorship. On his retirement in 1991 he became the Lewis M. Terman Professor Emeritus. He also became an American citizen in the 1990s.

Starting with his co-authorship with J. L. Pawsey of the first text on radio astronomy in 1955, Ron spent much of his time either contributing chapters to books or writing books, a number of which have been translated into other languages. These books include "The Fourier Transform and its Applications," (1965), "The Galactic Club: Intelligent Life in Outer Space," (1974), and as a final expression of a life-long interest in trees (particularly eucalyptus trees) "Trees of Stanford and Environs" (2005).

His Fourier Transform book was for many years the basis for a graduate level course that Ron himself introduced and taught, which was a must for every incoming graduate student in the Electrical Engineering department, and also for students from several other departments. This same course continues now to be arguably the most popular course in the EE department, taken by no less than 150 students each Fall. Ron enjoyed pointing out the fact that his book was translated into tens of languages, including Serbian, Chinese and others, and he was pleased to see the Third Edition come out in 1999.

In addition to his books, Ron also authored over 200 scientific papers on an extraordinarily wide range of topics. His work on imaging in astronomy led to fundamental contributions to tomography methods used in medical imaging, for which he was honored by the U.S. National Academy of Sciences in 1992 as a foreign member of its Institute of Medicine. Combining his knowledge of astronomy with geology, he theorized that some unusual layers (called "varves") in Australian red sandstones were connected with changes in the Sun's activity. His work on the Fourier transform led to a number of publications on what he christened the fast Hartley transform, which he felt was computationally more efficient than the Fast Fourier Transform, which is heavily used in signal analysis.

Ron displayed keen insight soon after the discovery of the cosmic background radiation in 1965 by determining, in collaboration with his Ph.D. student E. K. Conklin, several key properties of this remnant radiation from the "Big Bang." This electromagnetic radiation, now peaking at a wavelength of 1.9 millimeters (with the peak moving inexorably to longer wavelengths due to the expansion of the universe) is widely believed to mark the origin of the universe. They worked out the correct relativistic theory, built the required equipment, and established the directional uniformity of the radiation to an observational limit of better than one part in 1600, after correcting for Doppler effects. Their results were published in 1967, only two years after the first publication announcing the discovery of the radiation. It was many years before dedicated spacecraft improved upon their limit. Conklin went on to use the original measurements to establish estimates of the direction and speed of the Earth, solar system, and our galaxy through the velocity frame fixed by the radiation. When Ron gave the 1996 Bunyan Lecture at Stanford on "The Destiny of Man" he was introduced as one of the very few people who knew in which way, and how fast, we were going.

His dedication to writing did not prevent Ron from constructing a large 32-dish radio telescope to the west of the main campus in 1961 and using it to produce daily maps of solar radio activity that NASA made use of during the Apollo moon landings. The radio telescope, now dismantled, is thought to be the first to produce automatic plots of the Sun that could be disseminated worldwide to colleagues by teleprinter. He also designed and had constructed a sundial of unusual form that may currently be viewed on the south side of the Terman building. It is modeled after one that "once graced the Tower of the Agora in Athens," to quote from the plaque that was also prepared by Ron and installed beneath the sundial.

Another major achievement of Ron was the construction of a unique radio interferometer consisting of five 60-ft dish antennas that for many years was an icon on the back side of the Stanford foothills. When the University recently slated these antennas for destruction, there was a highly publicly visible effort by the so-called "Friends of the Bracewell Observatory", with support from many scientists worldwide, to save the antennas and instead refurbish them and use this site for educational outreach in radio astronomy. Ron was very interested in seeing this happen, but in the end graciously accepted the decision of the University that such use was not tenable.

Ron received numerous awards for his work. He was elected a Life Fellow of the IEEE and, in addition, in 1994 he received the IEEE's prestigious Heinrich Hertz Medal for his tomography work. He was particularly proud, if declaring himself a bit mystified, to be appointed an officer in the General Division of the Order of Australia, one of Australia's highest civilian awards. Since the award was for his service to science in the fields of radio astronomy and image reconstruction, his colleagues were not in the least mystified. It might be pointed out to those not well acquainted with the British system of honors, that the award entitled him to place the initials A.O. after his name and to wear an impressive gold medal to official functions.

Ron Bracewell is survived by his wife of 54 years, Helen. He is also survived by a son, Mark, of San Jose, Calif.; a daughter, Wendy, of London and Sheffield, England; a brother, Mark, of Melbourne, Australia; and two grandchildren. His family and friends, as well as the radio astronomy and electrical engineering communities, will long remember this remarkable Renaissance man and profound scholar.

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