OBITUARY

Donald E. Osterbrock (1924–2007)

Astrophysicist and historian of astronomy.

The internal structure and physics of stars such as our Sun, the physical conditions of the gas surrounding many hot stars in our Galaxy, and the workings of so-called active galactic nuclei are diverse areas of modern astrophysical research. Donald Osterbrock, who died on 11 January, made fundamentally important contributions to all of them, tackling their central questions with theoretical understanding and observational skill.

Osterbrock was born in Cincinnati, Ohio, on 13 July 1924, the son of an electrical engineering professor. By high school, he had decided that he wanted to be an astronomer. After army service in the Second World War, he attended the University of Chicago, which was at the time not only a leading centre of physics research, but also possessed of a distinguished faculty of astronomers. The solid grounding in theory and observation that Osterbrock received from such renowned names as Enrico Fermi, Gregor Wentzel, Subrahmanyan Chandrasekhar and Otto Struve was the foundation of his subsequent research career. His doctoral thesis, supervised by Chandrasekhar at Chicago's Yerkes Observatory, was a theoretical study of the dynamics of stars in galaxies as they interact gravitationally with a highly variable medium of stars, gas and dust.

After completing his PhD in 1952, Osterbrock spent a year as a postdoctoral fellow at Princeton University, where the internal structure and evolution of stars was the subject of intensive study. He became interested in low-mass stars similar to the Sun, called red dwarfs, whose radii and luminosities were not correctly predicted by theoretical models of the time. Osterbrock reconciled theory and observation by proposing that it was convective energy transport, associated with bulk turbulent motions of gas — rather than heat radiation as was generally assumed — that transported the energy in the outer portions of these stars. Inspired by this success, Martin Schwarzschild and Fred Hoyle, another visitor to Princeton at this time, used the convection model to compute the first successful models of red-giant stars.

In 1953, Osterbrock was invited to join the nascent astronomy department at the California Institute of Technology (Caltech), which had recently acquired a 200-inch-aperture telescope. Osterbrock's early observational research there included studies of the evolution of stars, both in 'globular clusters' found in the Milky Way and in nearby galaxies. But the future direction of

his research was determined around this time by a paper from the theoretical astronomer Michael Seaton. This contained calculations of the interaction probabilities for electrons and oxygen ions, and Osterbrock used the theory to embark on an extended study of O^+ and other ionic emissions from cosmic regions of ionized gas, or nebulae. In a short time, he had established himself as one of the world's leading authorities on gaseous nebulae.

At Caltech, Osterbrock started supervising what was to become a long list of PhD students, many of whom went on to distinguished careers — four became directors of major observatories. In 1958, he moved to help create a first-class department of astronomy at the University of Wisconsin, Madison. Osterbrock and his students were able to use the modern equipment there to continue his studies of gaseous nebulae.

The discovery in the early 1960s of quasars — a particularly luminous class of active galactic nucleus (AGN) radiating considerable amounts of energy from non-stellar sources — intensified interest in the study of external galaxies. The spectra of AGNs are often dominated by the same emission lines as those seen in gaseous nebulae, despite the physical conditions being clearly very different. Osterbrock was thus in an ideal position to unravel the mysteries of the poorly understood AGNs. Such research dominated the rest of his career, and he wrote a classic textbook on the subject, *Astrophysics of Gaseous Nebulae and Active Galactic Nuclei*, now in its third edition.

In 1973, Osterbrock became director of the Lick Observatory, headquartered on the University of California's Santa Cruz campus. One attraction held by the observatory was a 3-metre-aperture telescope fitted with a highly advanced electronic spectrograph that was ideally suited for Osterbrock's AGN research. During this time, assisted by a string of excellent students, he considerably expanded the classification scheme for different types of AGN, and also steadily improved physical and geometrical models of their structure.

Although Osterbrock carefully reserved about half of his time for research, he took his directorial responsibilities very seriously. During his tenure, the Lick Observatory went through a phase of rapid advances in instrumentation, culminating in the project to build a 10-metre-aperture telescope on a 'dark' site farther away from human light pollution. Two competing designs emerged, one with a primary mirror made of a single, thin meniscus of glass, and the other with

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a primary mirror made up of a mosaic of segments. The meniscus mirror would have been fairly straightforward to produce, whereas the mosaic mirror was more challenging, but weighed less. Each approach had strong supporters, and Osterbrock skilfully led the process that arrived at a choice: a segmented-mirror telescope. The result was the construction of the two Keck telescopes on Mauna Kea, Hawaii, the largest optical/infrared telescopes presently available.

Osterbrock felt uncomfortable with the administrative demands of leading the Lick Observatory when a major new observatory was being built, and he stepped down as director in 1981 to return to full-time teaching and research. In his later years, and especially following his retirement in 1991, he made a second name for himself as a historian of astronomy, writing several highly regarded biographies and histories of the Lick and Yerkes observatories. In 2004, a three-day symposium in honour of Osterbrock's eightieth birthday attracted astronomers and historians of the subject from far afield to Santa Cruz, many of them former students and colleagues. Don Osterbrock was the most sociable of scientists, and the animated discussions at the gathering's coffee breaks and lunches, with him at the centre and frequently punctuated with laughter, will be remembered by the unusually large number of close friends he had gained throughout the world. ■

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