

Allan Sandage

(1926–2010)

Astronomer who measured expansion rate of the Universe.

Allan Rex Sandage was one of the most prolific and influential astronomers of the second half of the twentieth century. Edwin Hubble and Walter Baade both left their scientific papers to him, and he continued the work of these two giants with spectacular results — including the first good estimates of the Hubble constant and the age of the Universe.

These are his best known achievements, but they comprised only a small part of his publications, which number in excess of 500. In 1956, Sandage became a staff member of the Mount Wilson and Palomar observatories in California; his retirement almost 50 years later did not stop him from working until the very end — his last paper is still in the press. He died, aged 84, on 13 November 2010 at his home in San Gabriel, California, from pancreatic cancer. He is survived by his caring astronomer wife Mary Sandage and his two sons David and John.

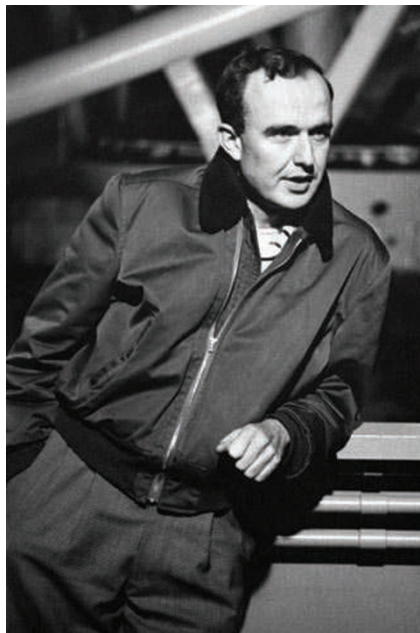
Sandage was born on 18 June 1926 in Iowa City, Iowa, as the only child of a powerful father — a professor of advertising — and loving mother. He received his BA in 1948 from the University of Illinois at Urbana-Champaign and then moved to the California Institute of Technology in Pasadena, California, for his PhD. Here he became Hubble's assistant in 1952, a year before completing his degree and Hubble's sudden death. He chose Baade as his thesis adviser, and Baade went on to teach him all the intricacies of the observing techniques of the time. This made Sandage, who spent roughly 2,000 nights at the telescope during his lifetime, an outstanding observer. He published the famous book *The Hubble Atlas of Galaxies*, followed by a further two colossal atlases containing some of the best ground-based pictures of galaxies ever taken.

EXPANDING THE UNIVERSE

From the very beginning of his career, Sandage was a star. His 1953 PhD thesis reversed the thinking of the day that faint 'main sequence' stars started their lives as red giants; his measurements of the M3 globular cluster led to the conclusion that the opposite order was correct. This was a revolution in the understanding of stellar evolution. Sandage continued to work on determining the distances and ages of clusters, as well as on the properties of their variable stars — the RR Lyrae and Cepheid stars — all his life. He was one of the first to use supernovae

to measure very large distances, and led a Hubble Space Telescope team to calibrate their luminosity.

By 1958, Sandage had massively revised Hubble's estimates of galactic distances, increasing them by a factor of about 7. From this he determined an expansion rate of the Universe, otherwise known as the Hubble constant, of about 75 kilometres per second per megaparsec, and an age of the Universe of around 13 billion years. Today's best estimates are, remarkably, essentially the same — albeit with smaller errors.



Perhaps his seminal work was his 1961 paper 'The ability of the 200-inch telescope to discriminate between selected world models', which has become the basis of modern observational cosmology. In it, Sandage calculated what the past and future would look like under different models of an expanding Universe and predicted the consequences for an observer.

On the back of these predictions, Sandage single-handedly mounted a giant programme to extend the Hubble diagram, which charts redshifts of galaxies (a measure of how fast they are moving away from Earth) against their relative distances. This became the crucial piece of evidence that helped to dispel doubts about whether very large redshifts are really caused by cosmic expansion, or by some as-yet-unknown physics. Such doubts,

fostered by Hubble himself, became prevailing when the stunningly large redshifts of quasars were discovered in 1963. Sandage's work was instrumental in settling the debate in favour of an expanding Universe.

QUIET DISCOVERIES

Sandage was actively involved in the discovery of quasars — enigmatic objects first detected by radio astronomers in the late 1950s. Sandage provided some of their first optical identifications and the first spectrum. He also co-discovered radio-quiet quasars, and showed that these objects greatly outnumber their radio-loud counterparts. In 1963, he co-wrote a paper on violent processes in galactic centres that anticipated today's explanation of quasars as being very distant galactic nuclei powered by black holes.

Sandage's most cited paper is from 1962, in which he theorized how the pancake-shaped Milky Way was formed by the collapse of a spherical gas cloud. This work remains the basis of modern theories of galaxy formation.

Sandage also authored several essays on the history of modern astronomy, including a monumental history of the Mount Wilson Observatory.

In mid-career, Allan became deeply concerned about the meaning of life. He studied the Bible and spoke in public about science and religion as "two separate closets in the same house". In the end he highly valued Christian philosophy, but did not find faith. He resolved to work to the limit of exhaustion. Some people thought that he was ambitious, but his drive came from his conviction that work was the only meaningful human activity. For Allan, life was not about fun.

Allan sometimes called himself a curmudgeon. But in his social life he was radiant with charm and wit; his after-dinner talks could make his audience explode with laughter. He loved books and was a fan of opera. His favourite time was sitting at the dark telescope, as he did for so many nights of his life, taking long exposures while the dome reverberated with the music of composer Richard Wagner. ■

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