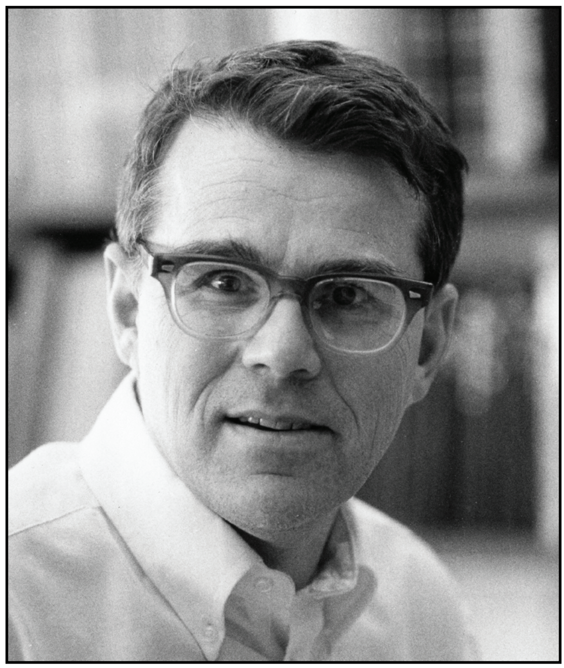
# GERRY NEUGEBAUER

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GERRY NEUGEBAUER was one of the founding fathers of infrared astronomy, guiding it from its dark age as a minor sideline of traditional astronomy to its current status as an indispensable tool for the study of planets, stars, interstellar dust, and galaxies. He achieved this through a combination of technical innovation, managerial skill, and a dedication to detail that inspired the dozens of students and postdocs that passed through his laboratory at Caltech.

Gerry Neugebauer was born in Gottingen, Germany, in 1932. His father, Otto Neugebauer, was an eminent historian of ancient astronomy and mathematics, and also a member of the American Philosophical Society. Gerry's family relocated to Copenhagen in 1934 and then to Providence, Rhode Island, in 1939, where his father took a faculty position at Brown University. Gerry received his undergraduate physics degree at Cornell University in 1954 and his Ph.D. in physics from Caltech in 1960 for his experimental work in high-energy particle physics.

After graduating, Gerry did his military service at the Jet Propulsion Laboratory in Pasadena. He was a key member of the science team for the successful infrared radiometer experiment of the Mariner 2 spacecraft flyby of Venus in 1962. His wife, Dr. Marcia Neugebauer, was a primary investigator of the Mariner 2 plasma analyzer, which made the first extensive measurements of the solar wind. She survives him and is still active in heliophysics research.

In 1962, Gerry accepted a position in the physics department at Caltech, joining Robert Leighton in a project to make the first extensive infrared sky survey. Knowing that they would never get enough observing time on any existing large telescope, they designed and built their own infrared telescope and installed it at the Mount Wilson Observatory. Its 62-inch-diameter epoxy mirror focused 2.2μm radiation of celestial objects onto a group of eight lead sulfide detectors that were cooled by liquid nitrogen. The signals were recorded on a strip chart recorder; computers at that time were still far too bulky, expensive, and unreliable to be installed at an observatory. Observations were carried out over a three-year period starting in 1965, resulting in a catalogue of 5,562 stars that were bright at infrared wavelengths.

As expected, the majority of objects in the survey turned out to be stars that had already been catalogued at visible wavelengths, but a surprising fraction of them did not correspond with bright stars. The most extreme of these, IRC +10216, is fainter than 18th magnitude in the visible, but at 5μm is the brightest object in the sky outside of the solar system. Its infrared spectrum indicated that whatever was causing the emission was at a temperature of about 650K—far cooler than the surface of any star observed until then. It was soon established that the emission originates from newly created hot dust grains flowing out from the dying star. Mass loss by old stars is now recognized as the main source of the dust grains that cause interstellar extinction and the main mechanism by which matter is recycled from old stars to make new ones.

Gerry and his students also built infrared photometers that could be mounted on the large telescopes at the Mount Wilson and Palomar Observatories. These instruments facilitated studies of small regions of sky with much better sensitivity, angular resolution, and wavelength range than was possible with the survey telescope. This approach led Gerry and his graduate student Eric Becklin to two major discoveries in the 1960s.

The first of these was a compact infrared source in the Orion Nebula. This object had no visible component although it was only 1 arc minute from the bright optical Trapezium stars. It was later shown to be the first known example of an infrared "protostar"—an immature star still deeply embedded within the interstellar cloud out of which it was forming.

The second of these discoveries was of infrared radiation from the nucleus of the Milky Way galaxy. Radio astronomers had estimated its position from observations of orbiting gas clouds and detected centimeter-wave radio emission from it, but at optical wavelengths, the galactic center is completely obscured behind thick clouds of interstellar dust. The infrared observations revealed an extended cluster of stars concentrated around the nucleus; the cluster would later be found to contain a massive black hole.

Astronomy at infrared wavelengths longer than 2.2μm is severely hampered by absorption in the Earth's atmosphere and background thermal radiation generated by both the atmosphere and the instrumentation itself. Pioneering experiments in the 5–100μm range were carried out in the 1960s using small, refrigerated telescopes carried to high altitude by rockets or balloons. Although the total amount of observing time from these surveys could be measured in hours, they revealed such tantalizing signs of new astronomical phenomena that scientists from the United States, the Netherlands, and the United Kingdom formed a collaboration to build the Infrared Astronomy Satellite (IRAS). Gerry played a leading role in the IRAS project on the design side but, most importantly, on the observational side; getting the data correctly calibrated and understood was always his primary goal.

The core of the IRAS satellite was a 57cm-diameter, liquid-helium-cooled mirror, which collected radiation in the 12–100μm range. It was launched in January 1983; when the liquid helium finally ran out, 10 months later, IRAS had mapped 96% of the sky. IRAS was a spectacular success with more than 250,000 sources catalogued. It showed once and for all that the infrared sky was vastly different from both the visible sky and the radio sky. Few astronomy surveys have ever impacted such a breadth of astronomical disciplines, including comets, stars, interstellar matter, and, especially, galaxies.

IRAS detected roughly 25,000 galaxies, the vast majority of which are spirals like the Milky Way. Hundreds of galaxies were discovered that emit more than 95% of their total luminosity in the infrared; these galaxies came to be known as "starburst" galaxies. Follow-up studies showed that many of these starbursts were actually colliding spiral galaxies in which rapid star formation had been triggered by the mutual impacts of molecular clouds from the two galaxies. Some of these starburst galaxies are as luminous as the most luminous quasars, but they produce their energy from newly formed stars rather than black-hole related activity.

Another IRAS discovery that Gerry was heavily involved in did not come from the survey itself but rather from the calibration effort. This was the discovery that some nearby main-sequence stars, such as Vega and Fomalhaut, have excess emission at infrared wavelengths, especially longward of 10μm. Careful work by the IRAS team showed that the infrared emission was coming from the region around the stars, while optical imaging of Beta Pictoris revealed a faint ring of dust particles orbiting the star. The discovery of these dust rings were one of the earliest clues that planets might exist beyond our solar system.

In 1980, Gerry was appointed the director of Palomar Observatory, where he initiated a major series of technical upgrades and improvements. They included reworking the support structure for the 200-inch mirror, improving the thermal properties of the telescope's dome, and image-sharpening equipment to correct for atmospheric distortion. Together they enabled the telescope to achieve diffraction-limited imagery at 2.2μm of 0.1 arc seconds—a factor of 10 improvement. Later, when the Carnegie Institute of Washington's support of the 200-inch telescope was reduced, Gerry was able to convince Cornell University to contribute to its operational costs, giving new life to the largest telescope in California.

In 1983, Gerry realized that Caltech needed to get involved in the development of the next generation of large telescopes that were being discussed. Jerry Nelson, a former student of his, had come up with an advanced design for an optical telescope with a 10-meter-diameter mirror made up of 36 smaller segments held in place by a servo-controlled mechanical support system. Gerry was impressed by Nelson's plans but knew that University of California had been unable to raise adequate funding to get the telescope built. Over the next few years, Gerry played a major role in bringing Caltech as a partner to UC and persuading the Keck foundation to provide the bulk of the funding for the project.

Gerry was a member of the National Academy of Sciences and the American Philosophical Society. During his career, he was awarded the Rumford Prize of the American Academy of Arts and Sciences, the Henry Norris Russell lectureship of the American Astronomical Society, the Herschel Medal of the Royal Astronomical Society, the Bruce Medal of the Astronomical Society of the Pacific, and the Space Science Award of the American Institute of Aeronautics and Astronautics. In 1986, he was named California Scientist of the Year.

Gerry Neugebauer's lasting legacy is not based on one or two major discoveries but on the ways he transformed the discipline of observational astronomy. His technical skills helped open three decades of the electromagnetic spectrum for astronomy, and his management skills played a leading role in breaking down the barriers between physicists and astronomers. Gerry had a great scientific intuition as to what was correct and possible, and he used it well. He was very driven, and although he expected those working with him to follow his example, he was also immensely patient, kind, and caring, treating students as scientific equals before sending them off to help turn infrared astronomy into one of the cornerstones of modern astrophysics.

Elected 1986

Eric Becklin
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