NASAfacts

SOFIA (Stratospheric Observatory for Infrared Astronomy)

SOFIA soars over the snow-covered Sierra Nevada mountains with its telescope door open during a test flight. SOFIA is a modified Boeing 747SP aircraft. Credit: NASA/Jim Ross

NASA's Stratospheric Observatory for Infrared Astronomy, known as SOFIA, was the world's largest airborne astronomical observatory. It complemented NASA's space telescopes and major ground-based observatories by capturing views of the universe in ways other telescopes couldn't.

SOFIA featured a 100-inch (2.5-meter) German-built infrared telescope mounted in the rear of a modified Boeing 747SP jetliner. The telescope, weighing 19 tons, operated high above the clouds, providing researchers with a unique window into the cosmos.

After more than eight years of scientific discovery, SOFIA completed its mission in September 2022.

The aircraft is now retired and on display at the Pima Air & Space Museum in Tucson, Arizona.

Powerful Tools for Space Exploration

SOFIA flew at altitudes between 39,000 and 45,000 feet — above 99% of the Earth's water vapor — allowing scientists to observe celestial objects in the infrared spectrum, which ground-based telescopes often can't detect due to atmospheric moisture.

Unlike space telescopes, SOFIA could return to the ground after each flight. That flexibility allowed scientists to switch out instruments, make upgrades, and adjust flight paths to catch rare astronomical events. Early science flights began in 2010. The first time the telescope gathered data — called "first light" — happened on May 25, 2010. SOFIA observed infrared light from the star Antares using a specialized camera developed by Cornell University.

SOFIA's first official science mission took place on Nov. 30, 2010, using that same camera to capture images of Comet Hartley, the Orion Nebula (Messier 42), and massive star-forming regions like W3 IRS5 and Sharpless 140.

One of SOFIA's notable achievements came when it flew thousands of miles to observe Pluto passing in front of a distant star. By catching the brief event, SOFIA helped scientists analyze Pluto's atmosphere — something that would have been impossible without the observatory's mobility.

Data collected by SOFIA helped researchers explore big questions, including how stars and planets form, how organic molecules develop in space, and how the supermassive black hole at the center of our Milky Way affects its surroundings.

Inspiring Educators and the Public

SOFIA's education and outreach efforts aimed to boost science, technology, engineering, and math (STEM) education in the U.S. and Germany.

Through the Airborne Astronomy Ambassadors program, middle and high school teachers — along with science museum educators — flew aboard SOFIA to experience astronomy research firsthand. Eight teachers participated in 2011, with 26 more flying during 2012 and 2013. These educators brought their experiences back to classrooms and communities to inspire students.

SOFIA also gave undergraduate and graduate students opportunities to work on instrument development, data analysis, and flight-based research — helping train the next generation of scientists and engineers.

From Development to Discovery

Full science operations began in 2014. Leading up to that, SOFIA went through alternating development and flight phases to install upgraded software, test instruments, modernize avionics, and perform regular aircraft maintenance. These upgrades helped ensure the observatory performed at a high level during its operational years.

SOFIA built on the legacy of pioneering astronomer Gerard Kuiper, who first championed airborne astronomy in the 1960s.

In this composite image of the Omega Nebula, SOFIA captured blue areas (at 20 microns) near the center, showing gas heated by massive stars near the bend. Green areas (at 37 microns) reveal warm dust heated by both massive stars and nearby newborn stars. Credit: NASA/JPL-Caltech

Kuiper's work with a small telescope in a modified jet eventually led to the Kuiper Airborne Observatory, a C-141 aircraft with a 36-inch telescope that flew from 1974 to 1995.

That mission helped discover Uranus's rings, water in comets, and star-forming regions in the Milky Way. SOFIA carried that legacy into the 21st century, continuing to push the boundaries of what we can learn from the sky.

A Collaborative Effort

Operated and maintained by NASA's Armstrong Flight Research Center in Palmdale, California, SOFIA was a joint project between NASA and the German Space Agency (DLR). DLR provided the telescope and supported aircraft maintenance. NASA's Ames Research Center in California oversaw program management and operations, in partnership with the Universities Space Research Association and the German SOFIA Institute at the University of Stuttgart.

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