



SOFIA 2010 – the year in review

28 April 2011

During 2010, SOFIA, the Stratospheric Observatory For Infrared Astronomy – a joint project of the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) and NASA – achieved programme goals and passed milestones at a pace almost as fast as the observatory can fly.

On 8 February 2010, Principal Investigator Terry Herter and his team from Cornell University and Ithaca College, both located in Ithaca, New York State, delivered what would become SOFIA's first operationally flown instrument, the Faint Object InfraRed Camera for the SOFIA telescope, or FORCAST. This instrument is a mid-infrared camera that records images in the 5 – 40 micron range (5 – 8 microns, 17 – 25 microns, and 25 – 40 microns, depending on the channels or filters selected). For comparison, the human eye sees radiation with wavelengths between 0.4 and 0.7 microns. The instrument was delivered to SOFIA's operations base at the NASA Dryden Aircraft Operations Facility (DAOF) in Palmdale, California, and was quickly set up in one of DAOF's laboratories. In the laboratory, engineers from the FORCAST team tested the instrument thoroughly to verify its performance before installing it on the SOFIA telescope.

Achieving 'first light'

Once the FORCAST instrument had been tested in the laboratory, it was mounted on the SOFIA telescope and a series of 'line-ops' or ground-based trials on the tarmac, began at sundown on 19 May. From the ground, the telescope tracked the planet Mars and spent a number of hours capturing images of Polaris, the North Star, to check alignment and focus. By 22 May, testing was complete and SOFIA's science staff took the weekend off to rest.

In astronomy, 'first light' is when photons from a celestial object travel down a telescope's tube for the first time. For SOFIA, first light was determined to be the first time a celestial object was imaged in flight – a little different to a ground-based telescope, but an event certainly worthy of celebration. At around 22:00 local time on 25 May, SOFIA took off from Palmdale for its first light flight. While cruising to its flight area, the telescope door was opened to cool the mirrors to a temperature between -30 and -40 degrees Celsius. In the late hours of 25 May, the FORCAST instrument recorded infrared light that had been emitted by the red supergiant star Antares (Alpha Scorpii) 550 years ago.

The observatory's second target for the evening was Jupiter, which was imaged at wavelengths of 5.4, 24, and 37 microns (24 microns is very hard to see from ground-based telescopes and 5.4 and 37 microns are impossible to see from Earth). The FORCAST instrument looked through the clouds of Jupiter to record heat radiating from the interior of the planet.

Observations of Jupiter were followed by a close look at the galaxy Messier 82 in the constellation Ursa Major. Peering through its obscuring clouds of dust and gas, SOFIA captured images of the star-forming heart of the galaxy, more than 10 million light years away. The first light flight was not only the first time light entered the telescope, but was planned as a demonstration of SOFIA's stability and versatility, imaging stars, planets and a galaxy on the same flight.

"Looking back on this accomplishment, I could not be more proud of our team in their commitment to the project, their dedication to completing the required flight tests, and meeting the first light milestone on schedule," said NASA SOFIA Programme Manager Bob Meyer.

"These tasks had to be completed before SOFIA could pass from being in the testing phase to becoming a flying observatory about to release world-class astronomical science results."

Observatory in operation

After the first light flight, SOFIA entered its 'Short Science' observing phase, which highlights the capabilities of the airborne observatory. The Short Science programme consists of three flights with FORCAST (accomplished at the end of 2010) and three observing flights in spring 2011 with the German REceiver for Astronomy at Terahertz Frequencies, or GREAT, a spectrometer developed by a team from the Max Planck Institute for Radio Astronomy (Max-Planck-Institut für Radioastronomie; MPIfR) in Bonn, lead by Principal Investigator Rolf Güsten. GREAT's first flight on board SOFIA will take place in April 2011. GREAT produces very high-resolution spectra at wavelengths between 60 and 200 microns and has been designed with a beam splitter that enables two channels to be monitored simultaneously.

"GREAT will provide a new opportunity to study the atmospheres of planets, examine the chemical composition of the interstellar medium and will expand our knowledge of circumstellar disks around young stars," said Hans Zinnecker, SOFIA Science Mission Operations Deputy Director, based at the University of Stuttgart. "The international collaboration between GREAT and SOFIA delivers one of the most versatile and unique astronomical instruments available for studying the far-infrared spectrum. In the foreseeable future, GREAT is the only instrument, ground- or space-based, able to collect such data."

In June 2010, SOFIA science staff and interested researchers gathered at the Asilomar Conference Center to discuss the next generation of instruments for SOFIA. Valuable input was received and incorporated into the parameters of NASA's announcement of opportunity for second-generation instruments. Final solicitation for new instruments will take place in mid 2011.

First science flights

SOFIA's first science flight took place on 30 November 2010. FORCAST Principal Investigator Terry Herter was on board leading the collection of data. Celestial targets imaged during the initial science flights included Comet Hartley and star-forming nebulae Messier 42, W3 IRS5 and Sharpless 140.

"SOFIA and its instruments will enable us to see regions of the Milky Way at infrared wavelengths that, at this time, cannot be observed with any other telescope, ground- or space-based," said NASA SOFIA Project Scientist Pamela Marcum. Marcum was on board SOFIA monitoring operations on the second science flight.

Looking ahead

In 2011, researchers expect to release scientific results from flights with SOFIA. NASA is planning to issue the final solicitation for new instruments around mid-year, and scientists will have the opportunity to apply for time on SOFIA in late 2011.

During 2011, the SOFIA team will be starting its Airborne Astronomy Ambassadors (AAA) programme, where educators will have the opportunity to participate in science operations with SOFIA researchers. The educators will then share their experience with the public by presenting workshops, training other teachers, and presenting programmes at schools, science centres and to groups within their local community. Additional information for educators can be found [here](#).

Bob Meyer summed up the excitement SOFIA has brought to the astronomical community by saying, "everyone on the SOFIA team has high expectations for this new phase of operations and we anticipate that more valuable and intriguing scientific results will come from our next set of observations."

The SOFIA programme is managed at NASA's Dryden Aircraft Operations Facility in Palmdale, California. The NASA Ames Research Center in Moffett Field, California, manages the SOFIA science and mission operations in cooperation with the Universities Space Research Association (USRA) in Columbia, Maryland, and the Deutsches SOFIA Institut (DSI) in Stuttgart.

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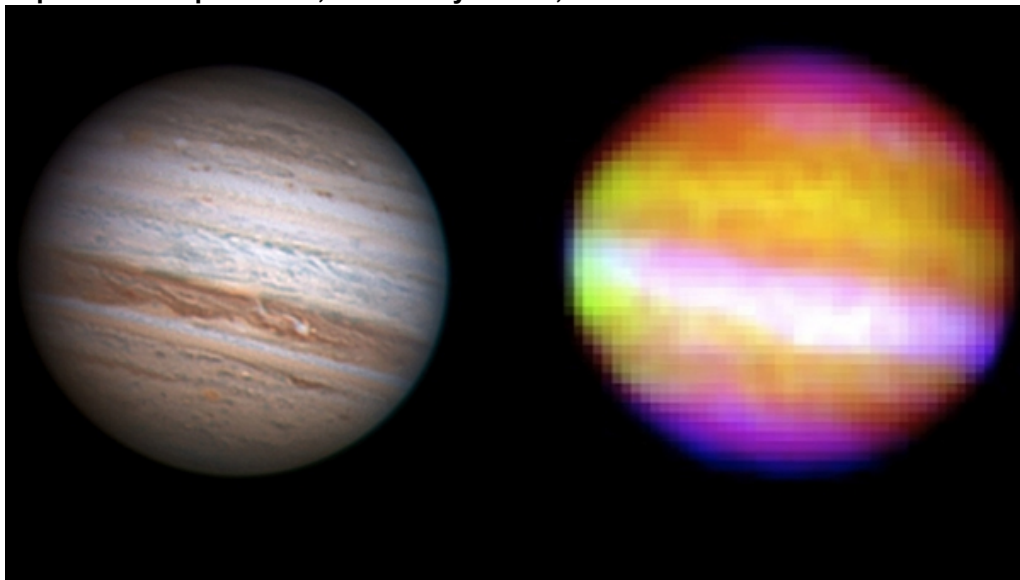
SOFIA during night-time test measurements in front of its hangar in Palmdale



SOFIA, the airborne infrared observatory, in front of its hangar at the Dryden Aircraft Operations Facility (DAOF) in Palmdale, California. The DAOF is operated by NASA's Dryden Flight Research Center. This photograph was taken during night-time test observations in March 2008.

Credit: NASA.

Jupiter in the optical and, as seen by SOFIA, in the infrared



Composite infrared image of Jupiter taken during SOFIA's first light flight acquired by Cornell University's FORCAST camera at wavelengths of 5.4 (blue), 24 (green) and 37 micrometres (red). A recent optical image of roughly the same side of Jupiter is shown for comparison. The white stripe in the infrared image is a region of relatively transparent clouds through which the warm interior of Jupiter becomes visible.

Credit: Optical image (left): Anthony Wesley, Infrared image (right): NASA/DLR.

SOFIA high above the NASA Dryden Aircraft Operations Facility in Palmdale



SOFIA above its base, a hangar at the NASA Dryden Aircraft Operations Facility (DAOF) in Palmdale, California (front/right).

Credit: NASA.

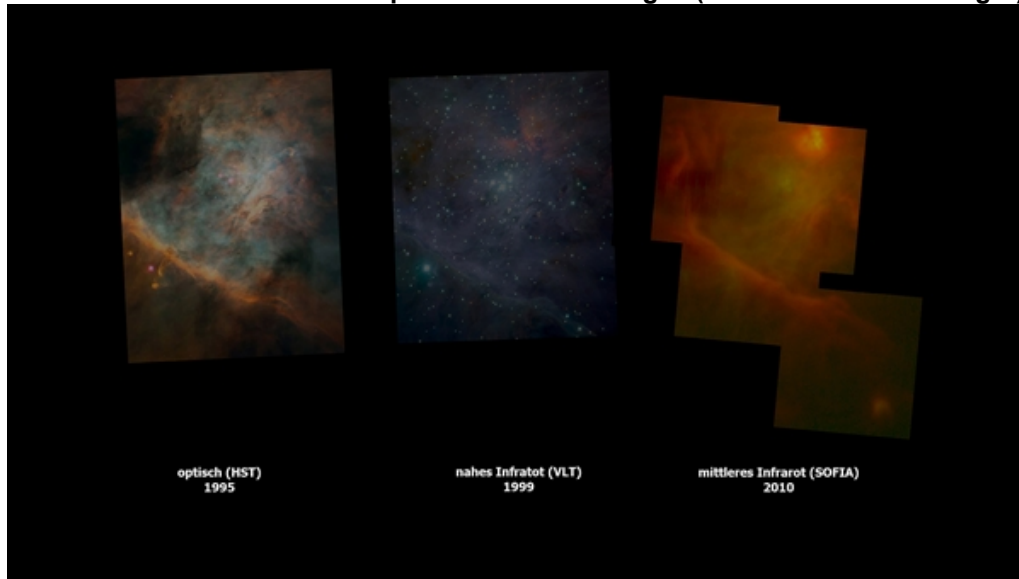
The Stratospheric Observatory For Infrared Astronomy, SOFIA



The Stratospheric Observatory For Infrared Astronomy, SOFIA, during its first test flight with its telescope exposed, on 13 July 2010. The German-built 2.5-metre infrared telescope is visible through the opening in the aircraft.

Credit: NASA/Jim Ross.

The Orion Constellation – comparison of three images (SOFIA/FORCAST at right)



This mid-infrared mosaic image from the SOFIA airborne observatory (right panel) offers new information about processes of star formation in and around the nebula Messier 42, in the constellation Orion. The image data were acquired using the Faint Object Infrared Camera for the SOFIA Telescope, or FORCAST, (principal investigator: Terry Herter, Cornell University) during SOFIA's Short Science 1 observing program in December 2010.

SOFIA's view combines images at mid-infrared wavelengths of 19.7 microns (green) and 37.1 microns (red). The latter wavelength cannot be accessed by any telescope on the ground or currently in space. Detailed structures in the clouds of star construction material can be seen, as well as warm clouds of dust and gas surrounding, and partly obscuring, a cluster of luminous new-born stars at the upper right.

The left and centre panels of the three-image comparison have the same scale and orientation as the SOFIA image.

The image in the left panel, made at wavelengths visible to the human eye, shows dense clouds of interstellar dust blocking our view into parts of the star forming region, plus the rosy glow of hydrogen gas excited by radiation from the young stars just above the centre of the image.

In the centre panel, the near-infrared image penetrates some of the dust and reveals numerous stars at various stages of formation, embedded inside the clouds.

SOFIA's observations reveal distinctly different aspects of the M42 star formation complex than the other images. For example, the dense dust cloud at the upper left is completely opaque in the visible-light image, partly transparent in the near-infrared image, and is seen shining with its own heat radiation in the SOFIA mid-infrared image. The hot stars of the Trapezium cluster are seen just above the centres of the visible-light and near-infrared images, but they are almost undetectable in the SOFIA image. At the upper right, the dust-embedded cluster of high-luminosity stars that is the most prominent feature in the SOFIA mid-infrared image is less apparent in the near-infrared image and is completely hidden in the visible-light image.

Credit: Left: NASA/ESA/HST/STScI/O'Dell & Wong; Center: Visible-light image (left): NASA/ESA/HST/AURA/STScI/O'Dell & Wong; Near-IR image (centre): ESO/McCaughrean et al.; Mid-IR image (right): NASA/DLR/SOFIA/USRA/DSI/FORCAST Team.

SOFIA, the Stratospheric Observatory For Infrared Astronomy



SOFIA, the Stratospheric Observatory For Infrared Astronomy, during the first test flight with the telescope door fully open, on 18 December 2009 over the Mojave Desert in California. The 2.5 metre telescope, built in Germany, is visible in the opening in the fuselage of this Boeing 747SP. The test flight with the door open helped engineers examine, for the first time under experimental conditions, the movement of air in and around the telescope and the door.

Credit: NASA/C. Thomas.

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