German Aerospace Center

Tracing the birth of stars in the Orion Nebula with FIFI-LS

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New infrared spectrometer from Germany on SOFIA, the airborne observatory

During its first scientific flight, the new infrared spectrometer FIFI-LS (**F**ield-**I**maging **F**ar-**I**nfrared **L**ine **S**pectrometer) investigated the birth of young stars in the Orion Nebula and nine other celestial regions. The instrument, carried on board the airborne observatory SOFIA (**S**tratospheric **O**bservatory **f**or **I**nfrared **A**stronomy) operated by the US space agency NASA and the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR), gathered important data on the formation of stars while simultaneously proving its suitability for this type of mission. This means that a second German instrument has successfully entered its operational phase on board SOFIA, in addition to the far-infrared spectrometer GREAT.

For stars to form, molecular clouds must cool

The Orion Nebula is located in the Milky Way at a distance of roughly 1300 light years from Earth. This celestial region is particularly interesting to science because it is one of the galaxy's most active star forming regions. The scientists used FIFI-LS specifically to analyse the Becklin Neugebauer Object – a stellar nursery containing both young stars and dense gas in which new stars are being created. For this to happen, the hot gas in the region must cool from an initial temperature of around 100 Kelvin (-173 degrees Celsius) to roughly 10 Kelvin (-263 degrees Celsius) – only then does the pressure within the cloud drop sufficiently to allow condensation to occur and stars to form.

Elements such as oxygen and carbon promote this cooling by radiating heat from inside the cloud to the exterior. Leslie Looney, the project's senior scientist from the University of Illinois, wants to find out, in detail, how this process works: "At very specific far-infrared wavelengths, oxygen and carbon radiate a substantial portion of the thermal energy found in the cloud, and FIFI-LS is perfectly equipped to detect this." SOFIA is currently the only observatory that enables investigations at these far-infrared wavelengths.

In addition, FIFI-LS observed nine other infrared objects, including the centre of the Milky Way, during the three scientific flights held on 21, 23 and 25 April 2014. "With FIFI-LS, one of the most modern far-infrared spectrometers is now fitted on board SOFIA," says Alois Himmes, SOFIA Project Manager at DLR. "Together with GREAT and four other NASA spectrometers and cameras, the scientists currently have six instruments with which they can study the infrared skies."

FIFI-LS was delivered to Palmdale, California, the home base of the SOFIA airborne observatory, back in November 2013, where it was prepared for its first mission. Two successful test flights were held at the beginning of March and mid-April 2014, during which scientists, engineers and technicians put the spectrometer's functionality and performance through an extensive series of tests.

FIFI-LS was initially developed and built at the Max Planck Institute for Extraterrestrial Physics (MPE) in Garching, near Munich, and from 2012 the Institute of Space Systems at the University of Stuttgart under the direction of Alfred Krabbe. The Deutsches SOFIA Institut (DSI), based at the University of Stuttgart, coordinates the airborne observatory's German operations.

SOFIA

SOFIA, the Stratospheric Observatory for Infrared Astronomy, is a joint project of the German Aerospace Center (DLR) and the US National Aeronautics and Space Administration (NASA). The German component of the SOFIA programme is being carried out under the auspices of DLR with funds from the Federal Ministry of Economic Affairs and Energy, the State of Baden-Württemberg and the University of Stuttgart. The development of the German instruments is funded by the Max Planck Society (MPG), the German Research Foundation (DFG) and DLR. Scientific operations are coordinated on the German side by the German SOFIA Institute (DSI) at the University of Stuttgart, and on the American side by the Universities Space Research Association (USRA).

Contacts

Diana Gonzalez
Deutsches Zentrum für Luft- und Raumfahrt (DLR) - German Aerospace Center
Corporate Communications
Tel.: +49 228 447-388
Fax: +49 228 447-386
Diana.Gonzalez@dlr.de

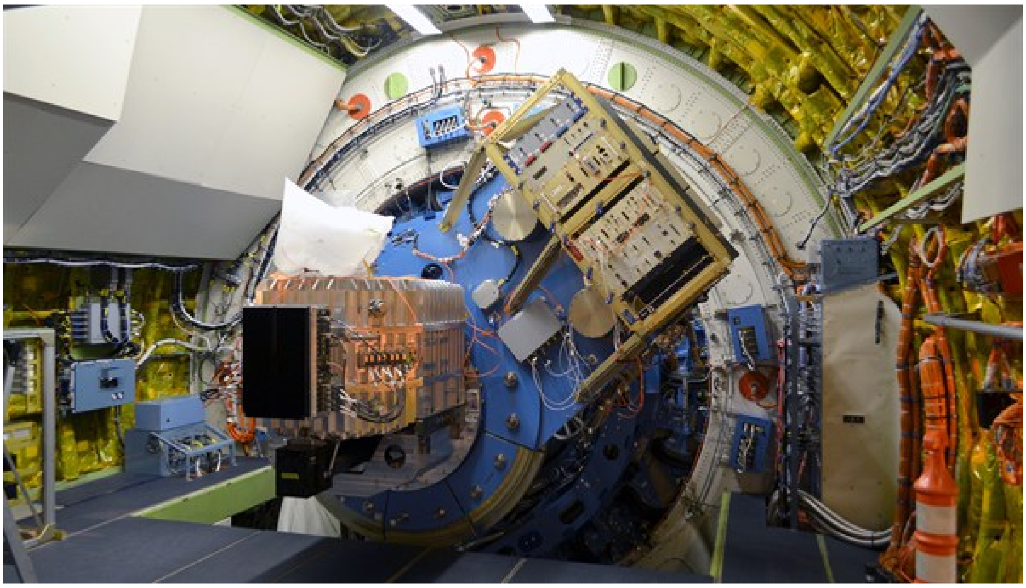
Heinz-Theo Hammes
German Aerospace Center (DLR)
Space Administration, Space Science
Tel.: +49 228 447-377
Fax: +49 228 447-745
Heinz.Hammes@dlr.de

The Orion Nebula

Image of the Orion Nebula acquired by the Spitzer space telescope. It shows the turbulent events in this conglomeration of young stars and the gas and dust clouds from which these stars have formed and others are still forming. In one of its first observation flights, FIFI-LS has also observed this active star forming region.

Credit: NASA/Spitzer Observatorium/Thomas Megeath.

The FIFI-LS instrument



The image shows the rectangular aluminium cryostat of the FIFI-LS instrument mounted on the telescope's blue supporting structure. The cryostat is filled with liquid nitrogen and liquid helium for cooling the optical elements and detectors to the required low temperatures. The dark-coloured boxes in front of and below the cryostat and the obliquely arranged 'instrument rack' above are the electronic boxes for control of FIFI-LS and data processing.

Credit: DSI.

The SOFIA airborne observatory

The NASA/DLR SOFIA observatory performs astronomical observations at infrared and submillimetre wavelengths above most of the effects of Earth's atmosphere. With a 2.7-metre primary mirror, SOFIA is the world's largest airborne observatory. This image shows SOFIA during a previous mission in 2013 at Christchurch International Airport in New Zealand. During the southern hemisphere winter, a total of nine research flights were conducted to observe the southern sky with the other German instrument, GREAT.

Credit: DLR (CC-BY 3.0).
