German Aerospace Center

Age of star nursery precisely determined for the first time

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SOFIA airborne observatory helps with accurate dating

How long does it take for a star to be born? To date, only this much has been clear: longer than there have been humans on Earth with the technology to observe it. But the precise age of a star-forming cloud has now been determined by a team under the leadership of scientists at the University of Cologne using the GREAT spectrometer on board the SOFIA airborne observatory. SOFIA, the Stratospheric Observatory For Infrared Astronomy, is operated jointly by the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) and the US space agency NASA. The results of the research conducted have now been published in the scientific journal Nature.

For their research, the scientists studied the IRAS 16293-2422 star-forming region, which is around 400 light years from Earth, in the constellation of Ophiuchus. The astonishing result is that the age of star-forming dense cores is of at least one million years – much longer than previous theories suggested. This model must now be verified. "Life as we know it is closely linked to the formation of stars and planetary systems. Hence, the exact processes involved in star formation are of fundamental importance in the investigation of the development of life on Earth," says Alois Himmes, DLR SOFIA project leader. "With its modern instruments, SOFIA has the best resources for making more ground-breaking discoveries in the coming years."

Hydrogen molecules act as 'chemical clock'

To determine the age of the interstellar cloud cores, the researchers used a new method in which they combined data from the GREAT receiver (German Receiver for Astronomy at Terahertz Frequencies) on SOFIA with that from the APEX telescope in Chile. In doing so, they used various forms of hydrogen as timepieces. Specifically, hydrogen was observed in the form of ortho and para H_2D^+ ions to do this. The ratio of these two variants to each other changes in a characteristic way as the period of star birth varies. This means that the scientists can read the concentration of molecules as a kind of chemical clock.

APEX provided the data on the ortho hydrogen, and GREAT recorded the spectral lines of the para hydrogen variant. The latter is particularly hard to measure on Earth as the atmosphere almost completely absorbs this radiation: "It was only possible to detect the first clear evidence thanks to the unique qualities of our GREAT instrument on board the SOFIA airborne observatory," says Jürgen Stutzki, whose research department at the University of Cologne made a significant contribution to the construction of GREAT.

The research work, in which scientists from the University of Helsinki and the Max Planck Institutes for Radio Astronomy in Bonn and Extraterrestrial Physics in Garching participated, was published in the online edition of Nature on 17 November 2014 (the print version comes out on December 4).

SOFIA

SOFIA, the Stratospheric Observatory For Infrared Astronomy, is a joint project operated by the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) and the National Aeronautics and Space Administration (NASA). The German contribution to the project is managed by DLR, using funds provided by the Federal Ministry for Economics Affairs and Energy (Bundesministerium für Wirtschaft und Energie), in accordance with a decision made by the German Federal Parliament (Bundestag), and funds from the State of Baden-Württemberg and the University of Stuttgart. The scientific operations are coordinated by the German SOFIA Institute ( ) on the German side, and by the on the American side. Development of the German instruments is financed using funds from the Max Planck Society (Max-Planck-Gesellschaft; MPG) and the German Research Foundation (Deutsche Forschungsgemeinschaft; DFG).

GREAT

GREAT, the German Receiver for Astronomy at Terahertz Frequencies, is a receiver for spectroscopic observations in the far-infrared spectral regime at frequencies between 1.2 and 5 terahertz (60–220 microns), which are not accessible from the ground due to absorption by water vapour. GREAT is one of two first generation German instruments for SOFIA developed by the Max Planck Institute for Radio Astronomy (MPIfR) and the University of Cologne, in collaboration with the Max Planck Institute for Solar System Research and the DLR Institute of Planetary Research. Rolf Güsten (MPIfR) is the project manager for GREAT. The development of the instrument was financed by the participating institutes, the Max Planck Society, the German Research Foundation (Deutsche Forschungsgemeinschaft; DFG) and DLR.

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Star-forming region in the constellation Aquila

The image, acquired by the Herschel Space Observatory, shows a star-forming region in the approximately 10,000-light-year distant interstellar molecular cloud W48 in the constellation Aquila. A number of already-evolved stars are visible, together with bright areas and dark gas clouds in which the star formation process has just begun. Such star formation processes have now been precisely dated for the first time using the GREAT instrument on SOFIA.

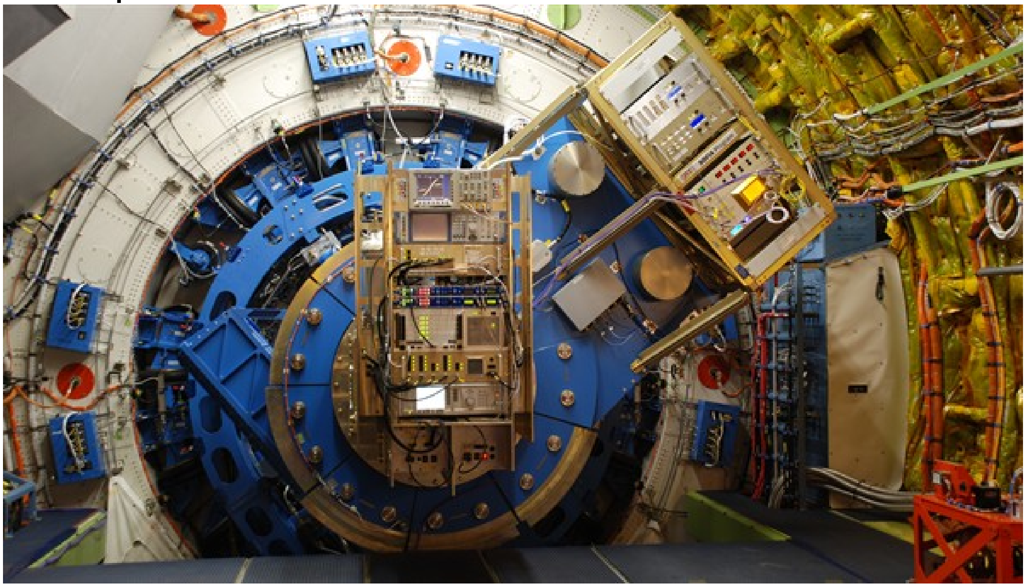
Credit: ESA/Herschel/PACS/SPIRE/HOBYS Key Programme consortium.

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).

GREAT spectrometer on board SOFIA



The GREAT far-infrared spectrometer (the vertical structure in the foreground) is mounted to the telescope counterweight flange inside the pressurised cabin. During observations, GREAT rotates ±20 degrees from the vertical, while the telescope (invisible on the far side) and its counterweight (seen here in blue at an angle of 45 degrees) move between roughly 25 and 65 degrees from the vertical.

Credit: GREAT-Team (R. Güsten).
