

A 101 Slide Set: From Supernovae to Planets

Developed by the SOFIA Team

Topic: Supernovae

Concepts: Supernovae,
planet formation, infrared
observations

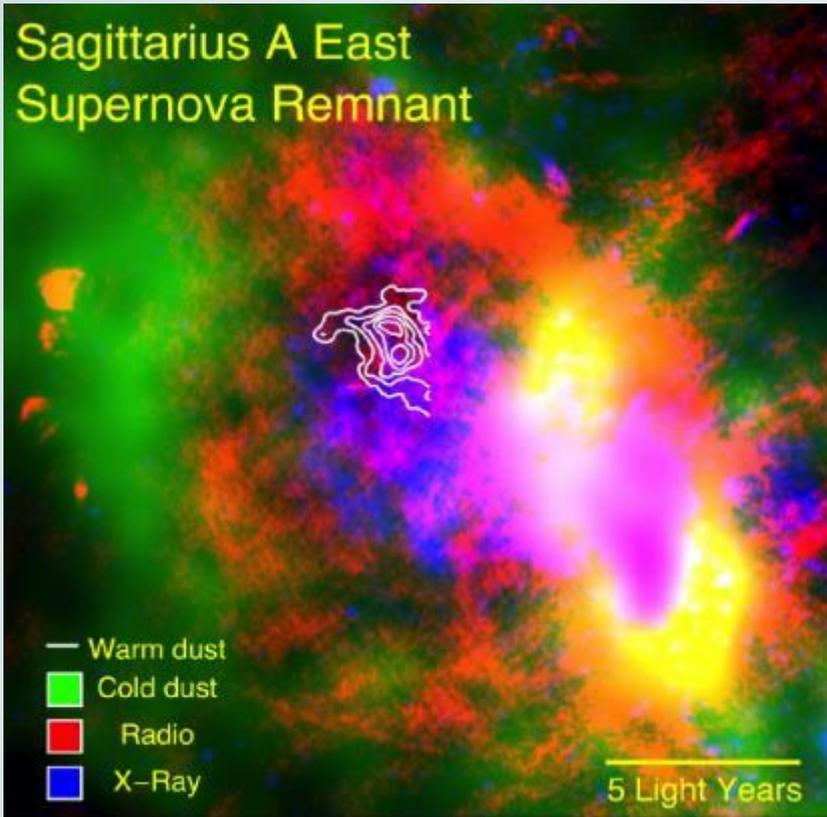
Mission: SOFIA

Coordinated by: the NASA
Astrophysics Forum

***An Instructor's Guide for using
the slide sets is available at the
ASP website***

<https://www.astrosociety.org/education/resources-for-the-higher-education-audience/>

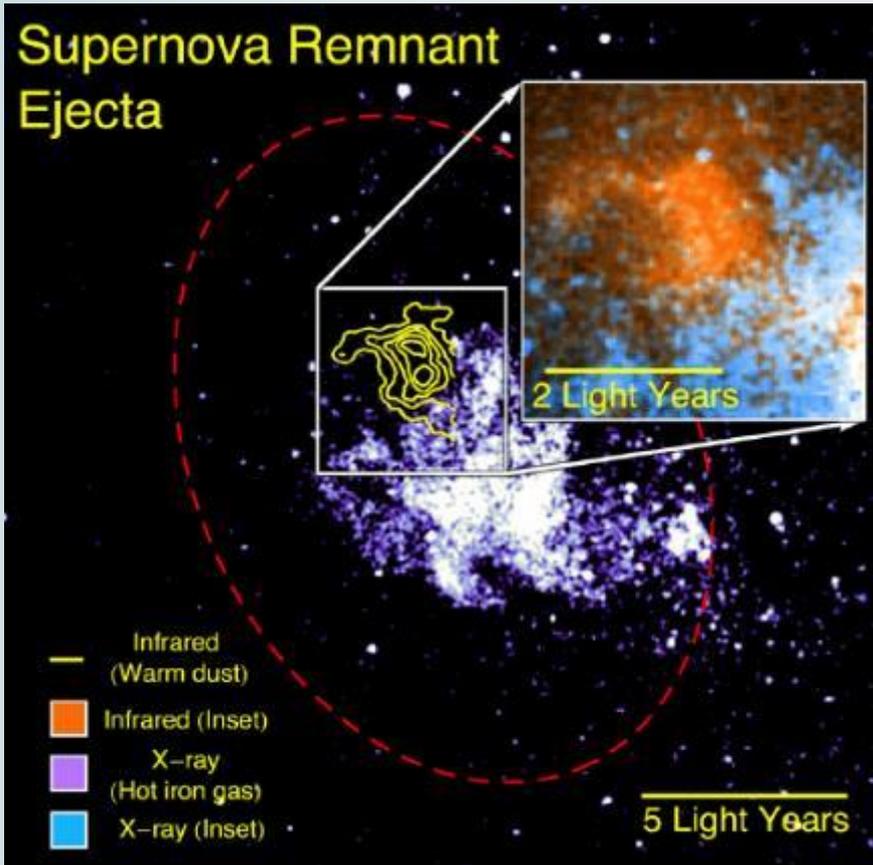
The Discovery



SOFIA data reveal warm dust (shown as white contour lines) surviving inside a supernova remnant (SNR) near the center of our galaxy. The SNR Sagittarius A East cloud is traced in X-rays (blue). Radio emission (red) shows expanding shock waves colliding with surrounding interstellar clouds (green). Credits: NASA/CXO/Herschel/VLA/SOFIA-FORCAST/Lau et al.

- Astronomers using data gathered by the Stratospheric Observatory for Infrared Astronomy (SOFIA) have found a massive dust cloud within the supernova remnant Sagittarius A East.
- The dust was created in the supernova explosion about 10,000 years ago that left behind the expanding, hot remains of the original star (the remnant).
- Astronomers estimate that the dust cloud contains enough material to create about 7,000 Earths.
- The discovery confirms that supernovae are capable of producing the material needed to form planets, and may be responsible for most of the dust found in young galaxies.

How was the Discovery Made?

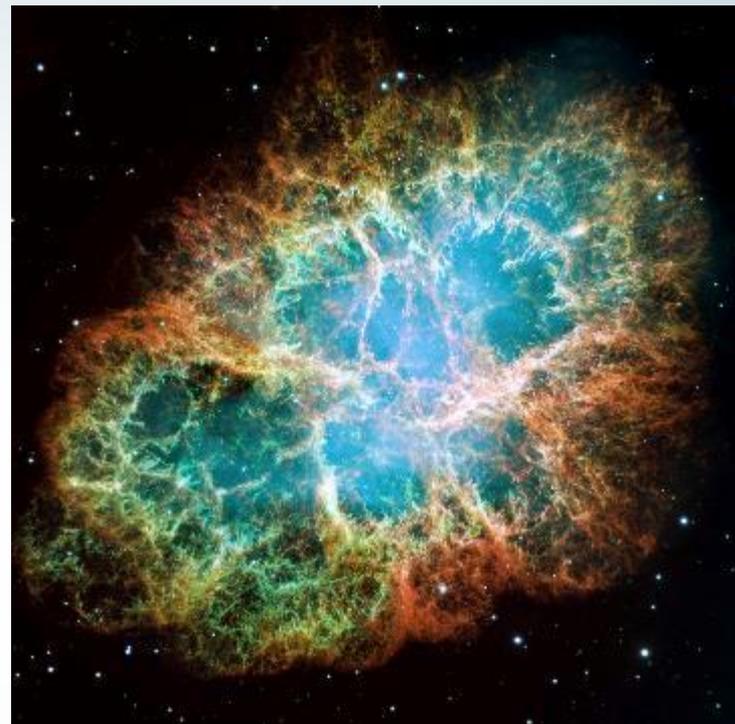


Supernova remnant dust detected by SOFIA (yellow contour lines) survives away from the hottest X-ray gas (purple). The red ellipse outlines the supernova shock wave. The inset shows a magnified image of the dust (orange) and gas emission (cyan). Credits: NASA/CXO/Herschel/VLA/SOFIA-FORCAST/Lau et al.

- Astronomers made detailed infrared observations of the Sagittarius A East supernova remnant using instruments aboard the SOFIA aircraft. They measured the long infrared wavelengths that can travel through intervening interstellar dust clouds to reveal activity in the center of the supernova remnant.
- They found infrared emission coming from a dust cloud, and measured the mass of the cloud based on the intensity of the emissions.
- The “contour map” of the dust cloud traces lines of equal intensity, with greater intensity lines in the center and lesser toward the outside. This maps the density of the cloud from the denser center to the less dense edges.

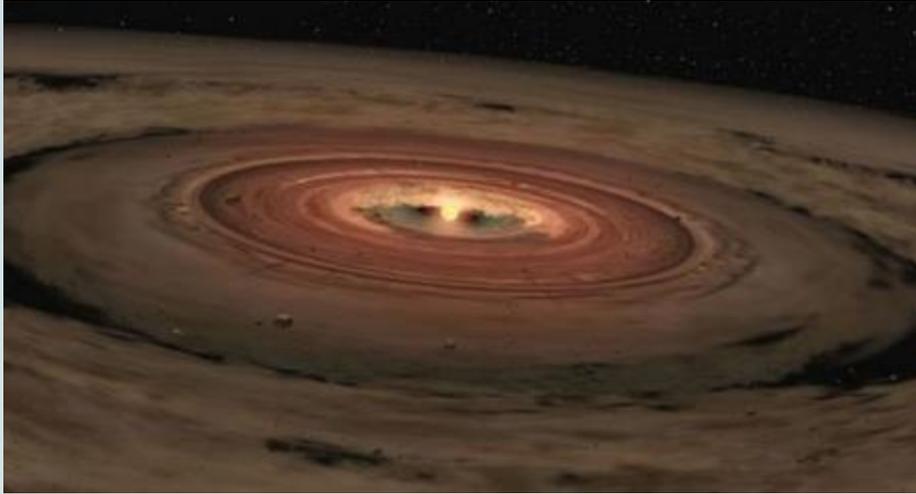
The Big Picture

- When massive stars end their lives in titanic explosions called supernovae, the chemical elements forged in the stars' interiors—and created in the heat and pressure of the explosion—are released into space as a debris cloud of hot gas and dust.
- Scientists had evidence of such dust formation, but couldn't be sure that the dust wasn't destroyed in the “rebound” shock wave when the expanding supernova remnant collided with the interstellar medium of thinly scattered material, creating another shock wave traveling inward toward the source of the explosion.
- The new finding demonstrates that supernova-formed dust can survive rebound shock waves and spread into space to form part of that interstellar medium from which stars—and planets—can form.



The Crab Nebula supernova remnant, created by an exploding massive star in AD 1054.
Credit: HST, NASA, ESA, J. Hester and A. Loll (Arizona State University).

What are the Implications?



Artist's concept of a stellar system in formation, in which leftover gas and dust in the disk surrounding a newborn star clump together to form planets. Credit: NASA/JPL-Caltech.

- The SOFIA finding demonstrates that supernovae not only produce dust, but that the dust can survive the explosion to become raw material for the formation of other stars—and planets.
- This result supports the notion that most of the dust observed in distant young galaxies may have been made by supernova explosions of early massive stars, since no other known mechanism could have produced nearly so much dust in the evolutionary histories of these galaxies.
- This result may provide the “missing link” between supernovae and planet formation, with dust produced by supernovae making possible planets like Earth!

Resources

Press Release:

https://www.sofia.usra.edu/News/news_2015/03_19_15/index.html

Original Publication:

[Old supernova dust factory revealed at the Galactic center](#)" (R. M. Lau, T. L. Herter, M. R. Morris, Z. Li, J. D. Adams)

<http://adsabs.harvard.edu/abs/2015Sci...348..413L>

<http://arxiv.org/abs/1503.07173>

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BONUS CONTENT

SOFIA

The Stratospheric Observatory for Infrared Astronomy (SOFIA) is a partnership of NASA and the German Aerospace Center (DLR), consisting of an extensively modified Boeing 747SP aircraft carrying a reflecting telescope with an effective diameter of 2.5 meters (100 inches). Based at NASA's Armstrong Flight Research Center in Palmdale, California, and capable of being deployed around the world, SOFIA is designed to fly at altitudes above most of the atmosphere, and nearly all of the water vapor, which absorbs the wavelengths it observes.

Its mobility and changeable instrumentation makes it an especially flexible observatory. For example, in June, 2015, SOFIA flew to the Southern Hemisphere to the narrow track in which Pluto occulted a star, providing complementary observations to those of the New Horizons probe just two weeks later.



SOFIA and its telescope. Credit: SOFIA, NASA.

