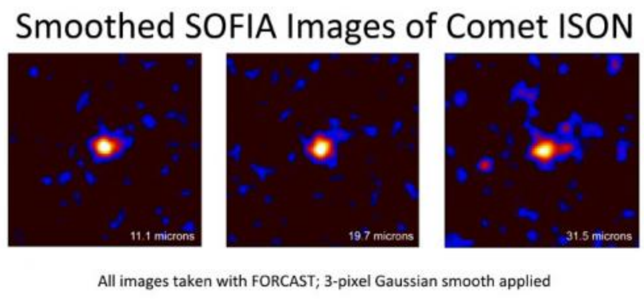
SOFIA's target of opportunity: Comet ISON

22 November 2013, by Nicholas A. Veronico



Images of Comet ISON were obtained by SOFIA's FORCAST camera at wavelengths of 11.1, 19.7, and 31.5 microns. Measurements at 31.5 microns, crucial for determining the temperature and other characteristics of the comet's material, cannot be made using ground-based telescopes. Credit: NASA / Diane Wooden

NASA's Stratospheric Observatory for Infrared Astronomy (SOFIA) embarked on a "target of opportunity" flight recently that included study of Comet ISON. The lengthy mission was SOFIA's second opportunity to capture data on a comet, having previously studied Comet Hartley 2 in 2010. For the Comet ISON observations, the target was predicted to be – and was—very faint.

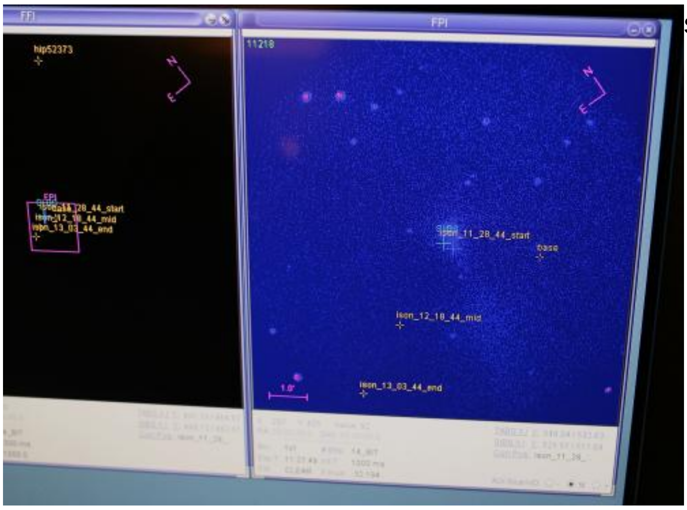
The observatory's flight path saw NASA's highly modified 747SP that carries a high-tech German-built 2.5 meter infrared telescope depart its home base at Palmdale, Calif., the evening of Oct. 24, 2013. It then flew east to Colorado, turned northeast and passed over the Canadian township of Pickle Lake, Ontario, then headed west over Medicine Hat, Alberta, where the observatory turned south and continued flying toward the United States. The comet ISON observations began south of the Canadian border, above the border of Idaho and Montana while SOFIA was flying at 43,000 feet altitude. The entire non-stop flight took nearly 10 hours to complete.

Comet ISON, a pristine chunk of primordial material from the Oort Cloud, recently entered the inner solar system for the first time and is heading toward a close encounter with the sun. On Nov. 28, 2013, Thanksgiving Day, Comet ISON will reach perihelion – the orbital point of closest approach to the sun—passing within 730,000 miles of the sun. The comet was discovered in September 2012, by researchers Vitali Nevski and Artyom Novichonk using the International Scientific Optical Network's (ISON) 0.4-meter (16-inch) telescope. It was then named in honor of the institution.

Comet studied at Three Wavelengths

Principal investigator Diane Wooden of NASA's Ames Research Center, who had proposed that Comet ISON be studied at three infrared wavelengths – 11.1, 19.7, and 31.5 microns, was aboard the Oct. 24 SOFIA flight. Two of those wavelengths, 19.7 and 31.5 microns, cannot be seen from Earth-based telescopes because water vapor in Earth's atmosphere blocks infrared energy from reaching the ground. The 31.5-micron wavelength was detected simultaneously with the 11.1 and 19.7-micron images.

The 11.1-micron wavelength allows the SOFIA observations to be tied to ground-based measurements with the Subaru Telescope on Mauna Kea, Hawaii, and the Great Canary Telescope on the island of La Palma, in Spain's Canary Islands. Currently, there are no space-borne telescopes operating at wavelengths longer than 4.5 microns, making SOFIA the only telescope able to see these limited wavelengths.



Comet ISON is seen looking through the telescope's Focal Plane Imager, a guide camera, on Oct. 24, 2013. The comet's tail extends to the lower right. The comet was very faint and was imaged at 11.1 and 19.7-micron wavelengths. Credit: NASA / Nick Veronico

Wooden, who made more than 75 flights on SOFIA's predecessor, the Kuiper Airborne Observatory, is working with a diverse team that will combine its numerous observations to better understand the composition of Comet ISON. Her observations aboard SOFIA were to measure the thermal emission from small and large dust grains in the coma of Comet ISON by measuring the mid-infrared wavelengths with the Faint Object InfraRed CAmera for the SOFIA Telescope (FORCAST) instrument. FORCAST collects infrared photons at wavelengths between five- and 40-microns.

"The long wavelength photometry, only possible from SOFIA, will allow us to measure the thermal emission from larger grains, which cannot be seen in scattered light at visible wavelengths," said Wooden. "Compared with smaller submicron grains, larger grains have cooler temperatures and emit at longer wavelengths.

"Only the FORCAST instrument on SOFIA can obtain the longer wavelength photometry measurements that sample the thermal emission of the larger grains," she explained. "By modeling the FORCAST photometry, we can constrain the grain size distribution and the dust mass. The mass and loss rate of the dust are one of the fundamental characterizations of a comet."

Making the Observations

"When we got onto the comet leg of the flight, we clearly saw the extended coma in the fine guiding camera but not in the wide-angle camera," Wooden said. "We acquired images at 11.1 microns and immediately saw the comet was faint. We then shifted to the 19.7-micron filter, where the comet was expected to be brighter.

SOFIA FORCAST instrument scientist James DeBuizer (left) consults with principal investigator Diane Wooden (right) during the Comet ISON observations. Credit: NASA / Nick Veronico

"Soon we could see the comet was about as weak at 19.7 microns as it was 11.1 microns, consistent with the expectations of a typical grain-size distribution, Wooden continued. "If the 19.7-micron images had a stronger signal, that would have meant there were more, larger grains.

Wooden said these measurements are important because they serve as constraints or upper limits on the flux of thermal emissions from larger dust grains in the coma.

"Studying the dust's thermal emission from SOFIA enables us to derive the grain size, its distribution, and the mass of the amount of dust coming from the comet," she said. "This is a critical complement to studying the gases that are released, and thereby contributes significantly to understanding the origins of comets.

"We learned that the comet is dust-poor not only for small grains, as already known by the weak scattered light at visible wavelengths, but also for larger grains detectable at these mid-IR wavelengths from SOFIA," Wooden concluded.

Provided by NASA