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Stratospheric Observatory for Infrared Astronomy (SOFIA) for Planetary Science and the Kuiper Belt

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Abstract

The Stratospheric Observatory for Infrared Astronomy (SOFIA [1]) is a 2.5 meter telescope on a modified 747SP aircraft. The program is managed by the National Aeronautics and Space Administration (NASA) and the Deutsches Zentrum für Luft- und Raumfahrt (DLR). Operations are supported by NASA and DLR in a partnership, with an 80/20 split per international Memorandum of Understanding.

1. Status and News

SOFIA's first light flight occurred in May 2010, with all systems performing acceptably. The Early Science program is nearing completion at the time of writing. Three Short Science flights with the FORCAST instrument occurred in 2011 December, followed by three Short Science Flights with GREAT in 2011 April.

An open proposal call was issued for Basic Science, followed by an call within the German community for Demonstration Time. The FORCAST Basic Science observations have are nearing, with the 8th flight taking of the night of writing this abstract. The instrument team from Cornell, science operations crew from the Science Mission Operations center, Guest Investigators, educators, and journalists have all participated in these flights.

2. Observatory Capabilities

2.1 Telescope

The 17-ton SOFIA telescope was provided by Germany. The telescope has an agile secondary mirror that can chop at 1-5 Hz for atmospheric suppression. The telescope is mechanically isolated from the aircraft on a hydrostatic beating, and active stabilization is using gyros. The telescope performed admirably on its commissioning flights, exceeding its requirement of providing stabilized images smaller than 4″.

2.1 Science Instruments

There are 7 scientific instruments developed or being developed for SOFIA (see the Table). NASA is issuing a call for proposals in early 2011 (the draft is already posted) for Second-Generation instruments, including the possibility of upgrading existing instruments: http://soma.larc.nasa.gov/SOFIA/

3. Early Scientific Results

During the first science flights with FORCAST, Jupiter and comet Hartley 2 were observed. Figures 1 and 2 show the results.

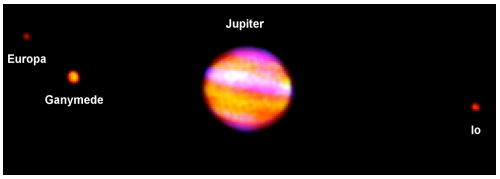

Figure 1: False-color image of Jupiter and 3 Jovian satellites obtained by SOFIA in May 2010. In blue is the 5.4 μm image, in green, the 24.2 μm image, and in red the 37.1 μm image. This image was taken using FORCAST by Principal Investigator T. Herter (Cornell) and the color image was created by J. DeBuizer (USRA).

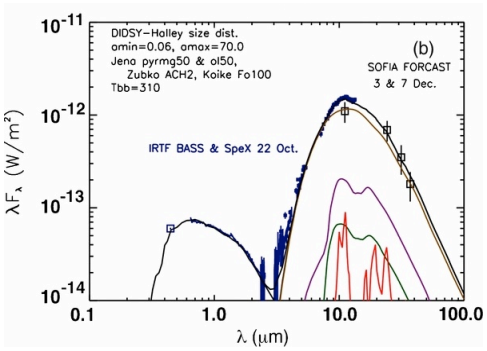

Figure 2: Spectral energy distribution of comet Hartley 2 obtained as part of the Earth-based support campaign for the EPOXI mission. The SOFIA data points are shown as symbols from 11 to 37.1 μm [2]

4. Planetary Science Capabilities

4.1 Planetary Atmospheres

The opacity sources of giant planet atmospheres in the mid- to far-infrared include molecular species, such as the H2 features that dominate the opacity of at 20-40 μm as seen with Spitzer. In the inner Solar System, Venus is a special case because it has been inaccessible to infrared spectroscopy (with cryogenic infrared space telescopes necessarily avoiding the sunward viewing hemisphere). SOFIA can target Venus and using mid-infrared spectroscopy it is sensitive to the vertical and wind profiles, atmospheric structure, Cl abundance, and SO and SO2. For Mars, we expect to detect methane using high-resolution mid-infrared spectroscopy by EXES and the Doppler shift to move the Martian feature relative to the terrestrial one. In Titan, hydrocarbon chemistry can be addressed.

4.2 Kuiper Belt

The HIPO instrument (Principal Investigator T. Dunham) was specifically designed for planetary science, including stellar occultations by Kuiper Belt objects as well as extrasolar planet transits. SOFIA/HIPO will achieve few-km resolution at 30 AU distance to measure sizes and shapes of Kuiper Belt Objects. HIPO can be dual-mounted with FLITECAM to allow simultaneous near-infrared and visible observations of occultations and measure properties of KBO atmospheres.

An observing campaign is scheduled for 2011 June, to observe an occultation by Pluto with an attempt to fly through the midline of the event and observe the central flash due to atmospheric refraction. Results will be obtained by the time of this conference.

5. Proposal Calls

SOFIA will have an annual proposal call. The Cycle 1 call is to be issued by 2011 November with a submission deadline soon after New Year's 2012. We anticipate offering FORCAST imaging and grism spectroscopy, FLITECAM imaging and grism spectroscopy, GREAT, and HIPO. All first-generation instruments willl be commissioned by 2013.

References

[1] Becklin, E.E., Gehrz, R.D. 2009, SPIE 7453, p. 745302
[2] Meech, K., et al. *EPOXI*: Comet 103P/Hartley 2 Observations from a Worldwide Campaign, Astrophysical Journal Letters, Vol. 734, pp. L1-L9, 2011

Instrument	Wavelength	Capability	Availability
GREAT	60-200 μm	High-resolution spectra	**2011**
FIFI LS	42-210 μm	Integral field spectra	2013
HAWC	50-240 μm	Filter images	2013
EXES	5-28 μm	High-resolution spectra	2012
FORCAST	5-40 μm	Filter images, grism spectra	**2010**
FLITECAM	1-5 μm	Filter images, grism spectra	2011
HIPO	0.3-1.1 μm	High-time-resolution photometry	2011