Astrochemistry: Recent Successes and Current Challenges
Proceedings IAU Symposium No. 231, 2005
D.C. Lis, G.A. Blake & E. Herbst, eds.

doi:10.1017/S1743921306007332

Stratospheric Observatory for Infrared Astronomy (SOFIA)

E. E. Becklin

University of California Los Angeles, 405 Hilgard Ave,
Los Angeles, CA, 90095 USA
email: becklin@astro.ucla.edu

Abstract. The joint U.S. and German SOFIA project to develop and operate a 2.5-meter infrared airborne telescope in a Boeing 747-SP is now in the final stages of development. First science flights will begin in 2008. The observatory is expected to operate for over 20 years. The sensitivity, characteristics, science instrument complement, and examples of 1-st light spectroscopic astrochemistry science are discussed.

Keywords. airborne astronomy — astrochemistry — infrared: sub-millimeter

1. Introduction

The Stratospheric Observatory For Infrared Astronomy (SOFIA) is NASA's and DLR's premier observatory for infrared and submillimeter astronomy. A Boeing 747-SP aircraft will carry a 2.5-meter telescope designed to make sensitive infrared measurements of a wide range of astronomical objects. It will fly at and above 12.5 km, where the telescope collects radiation in the wavelength range from 0.3 μm to 1.6 mm. SOFIA is being developed and operated for NASA and DLR by USRA.

The telescope and 20% of operations will be supplied by Germany through contracts with DLR (German Space Agency). The University of Stuttgart has been awarded the contract to run the Deutsches SOFIA Institut (DSI). The development of the science instruments to be attached to the SOFIA telescope will be the responsibility of the U.S. and German science communities. In the U.S., science instruments will be designed and built at universities and national centers through a USRA peer-review process.

2. SOFIA First Light Instruments

A total of nine instruments have been selected and are now under development (see Table 1). The selection includes three Facility Class (FI) Science Instruments (HAWC, FORCAST, and FLITECAM) and six Principal Investigator Class (PI). Facility Class instruments are maintained and operated by the SOFIA Science and Mission Operations Center (SSMOC) staff. PI Class instruments are operated by the PI. Two of the PI Class instruments are being developed in Germany.

3. First Light Expected in 2008

SOFIA will see first light in 2008, and is planned to make more than 120 scientific flights per year of at least 8 to 10 hours duration. SOFIA is expected to operate for at least 20 years, primarily from Moffett Field in California, but occasionally from other

Table 1. SOFIA First Light Instruments

PI	Institution	Name	Type of Instrument
E. Dunham	Lowell Observatory	HIPO	High-speed Imaging Photometer for Occultations $0.3 - 1.1\ \mu$m
I. McLean	UCLA	FLITECAM	Near-IR Camera $1 - 5\ \mu$m; GRISM $R = 2,000$
J. Lacy	Univ. of Texas	EXES	Echelon Spectrometer $5 - 28\ \mu$m; $R = 10^5, 10^4$, or 3000
T. Herter	Cornell	FORCAST	Mid IR Camera 5–40 μm
D.A. Harper	Univ. of Chicago	HAWC	Far IR Bolometer Camera $50 - 240\ \mu$m
A. Poglitsch	MPE, Garching	FIFI LS	Field Imaging Far IR Line Spectrometer $40 - 210\ \mu$m; $R \sim 2000$
S. Moseley	NASA-GSFC	SAFIRE	Imaging Fabey-Perot Bolometer Array Spectrometer $145 - 655\ \mu$m; $R = 1,000 - 2,000$
R. Güsten	MPIfR, KOSMA	GREAT	Heterodyne Spectrometer $60 - 200\ \mu$m; $R = 10^4 - 10^8$
J. Zmuidzinas	Caltech	CASIMIR	Heterodyne Spectrometer $200 - 600\ \mu$m; $R = 10^4 - 10^8$

Table 2. System characteristics of SOFIA

Nominal Operational Wavelength Range	0.3 to 1600 μm	Diffraction-Limited	$\geqslant 15\ \mu$m
Pointing Stability	$1\farcs0$ rms at first light	Nominal System f-ratio	19.6
Pointing Accuracy	$0\farcs5$	Telescope Emissivity	10%
System Clear Aperture Diameter	2.5 meters	Recovery Temp.	240 K
Telescope's Unvignetted Elevation Range	20 to 60°		
Unvignetted Field-of-View Diameter	$8'$		
Maximum Chop Throw on Sky	$\pm 4'$ (unvignetted)		

bases around the world, especially in the Southern Hemisphere. SOFIA will fly above 12.5 km, where the typical water vapor column density is less than 10 μm.

The SSMOC, to be operated by USRA, will be located at NASA Ames Research Center at Moffett Field in the same hangar housing SOFIA. The SOFIA Program will support approximately 50 investigation teams per year.

The finished telescope has been mated into the modified aircraft and was tested in 2004. First test flights will occur in 2007, and first science in 2008.

4. Science Potential

With the parameters given under SOFIA Characteristics in Table 2, and the atmospheric transmission at flight altitudes given in Traub & Stier (1976) we calculate that SOFIA will be as sensitive as the CSO in the 350 and 450 μm windows, but for 80% of all molecular lines from 60 to 600 μm. SOFIA will be 3 times less sensitive than Herschel for heterodyne spectroscopy in the region 150 to 600 μm; advances in detectors during and after the Herschel mission should close that gap.

Using the first light heterodyne instruments, spectral surveys can be made to reveal many lines in the broad atmospheric window from 60 to 600 μm. Many new molecular lines will be observed for the first time. Of particular interest are the light molecules, such as HD at 112 μm and HF at 243 μm.

Reference

Traub, W.A., & Stier, M. 1976, *Appl. Optics* 15, 364

https://doi.org/10.1017/S1743921306007332 Published online by Cambridge University Press