The
Stratospheric Observatory for Infrared Astronomy (SOFIA)
and the Transient Universe

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Airborne astronomy has a heritage of prompt response to transient astronomical events.

- Go where you need to go when you need to go
- Take instruments that are scientifically relevant
- Get above the clouds and most of the water
  - Permit real time observation planning
    - Offer “hands-on” space science
Airborne Astronomy

Stratospheric sky is largely transparent in optical and IR.

Routine access to clear skies, at desired times and places.

Large telescopes and cutting edge instruments.
Eclipse chasing in B17  Convair 990 - Galileo  0.3m LearJet Observatory

0.9m Kuiper Airborne Observatory
SOFIA Overview

- 2.5 m telescope in modified Boeing 747SP aircraft
- Service to 45,000 feet - above > 99.8% of obscuring water
- Joint Program between the US (80%) and Germany (20%)
  - Ops: Science at NASA-Ames; Flight at Dryden FRC in Palmdale
  - >120 8-10 hour flights per year
SOFIA open-door flight
December 18, 2009
First light this April!
First instrument already delivered to ops facility

8 first generation instruments  \( R = 10 - 10^8, \lambda = 0.6 - 800 \mu m \)

Early science

• “Short” science - summer 2010; limited capabilities, shared risk
• “Basic” science - early 2011; full capabilities, call in April

• Ramp up to 1000 flight hours/year by 2014 (more than 2x KAO)

http://www.sofia.usra.edu/
1st generation

early science
FORCAST
Faint Object infraRed CAmera for the SOFIA Telescope
• Mid IR, two-channel camera
• 0.75”/pixel 4-8 μm, 16-40 μm

GREAT
German REceiver for Astronomy at Terahertz frequencies
• Heterodyne spectrometer
• Dual-channel 1.6-1.9 THz, 2.4-2.7 THz

• SOFIA New Instrument Workshop - Asilomar, June 2010
  “Scientific Opportunities For New Instrumentation”
  http://www.sofia.usra.edu/Science/workshops/asilomar.html

• Call for 2nd generation science instruments - late 2011

Be there!
Occultation Astronomy with SOFIA

Helping determine the properties of small Solar System bodies

- Occultation studies probe sizes, atmospheres, satellites, and rings and small bodies in the solar system.

- SOFIA can fly anywhere on Earth to position itself in the occultation shadow. Hundreds of events available per year compared to a handful for fixed ground observatories.
Occultations and Atmospheres

This occultation light curve observed on the KAO (1988) probed Pluto’s atmosphere

J. L. Elliot et al., Icarus 77, 148-170 (1989)

Isothermal above 1220 km with strong inversion layer below 1215 km

Occultations: Rings and Moons

This occultation light curve observed on the KAO in 1977 shows the discovery of a five ring system around Uranus

J. L. Elliot, E. Dunham, and D. Mink, Nature 267, 328-330 (1977)
Comets in the Inner Solar System

JWST exclusion zone <85º from Sun
(Herschel ““ <60º “ “)

Cryogenic infrared observatories are strongly constrained by solar exclusion zone.

With elevation limit of 20º, SOFIA can reach much closer to the Sun. Pointing limited.

Production rate of water and organic volatile emission is strongly enhanced at <1AU for comets. The inner solar system is particularly revealing of comet composition.
Ortho/para ratios are indicative of ice formation temperature.

The spectrum of cometary volatiles is especially rich in the inner solar system, with strong representation from organics.
SOFIA and Classical Nova Explosions

What can SOFIA tell us about gas phase abundances and dust minerology in classical nova explosions?

- Amorphous carbon
- SiC
- Amorphous silicates
- Hydrocarbons

- Gas phase abundances of C, N, O, Mg, Ne, Al
- Spectral R and $\lambda$ coverage of dust components
- Kinematics of the ejection
- Contributions to ISM clouds and primitive solar system
SOFIA and Local Supernovae!

What can SOFIA tell us about the energetics of supernovae?

- Heavy elements produced in advanced nuclear burning stages
- Dust echoes from heated ISM
- Dust formation in outflow.

Rank et al. 1988
SOFIA will bring …

flexible planning,
observational convenience,
atmospheric transparency,
and cutting edge instrumentation
to studies of the transient universe.

Stay tuned!