Stratospheric Observatory for Infrared Astronomy

Solar System Science with the Stratopsheric Observatory for Infrared Astronomy

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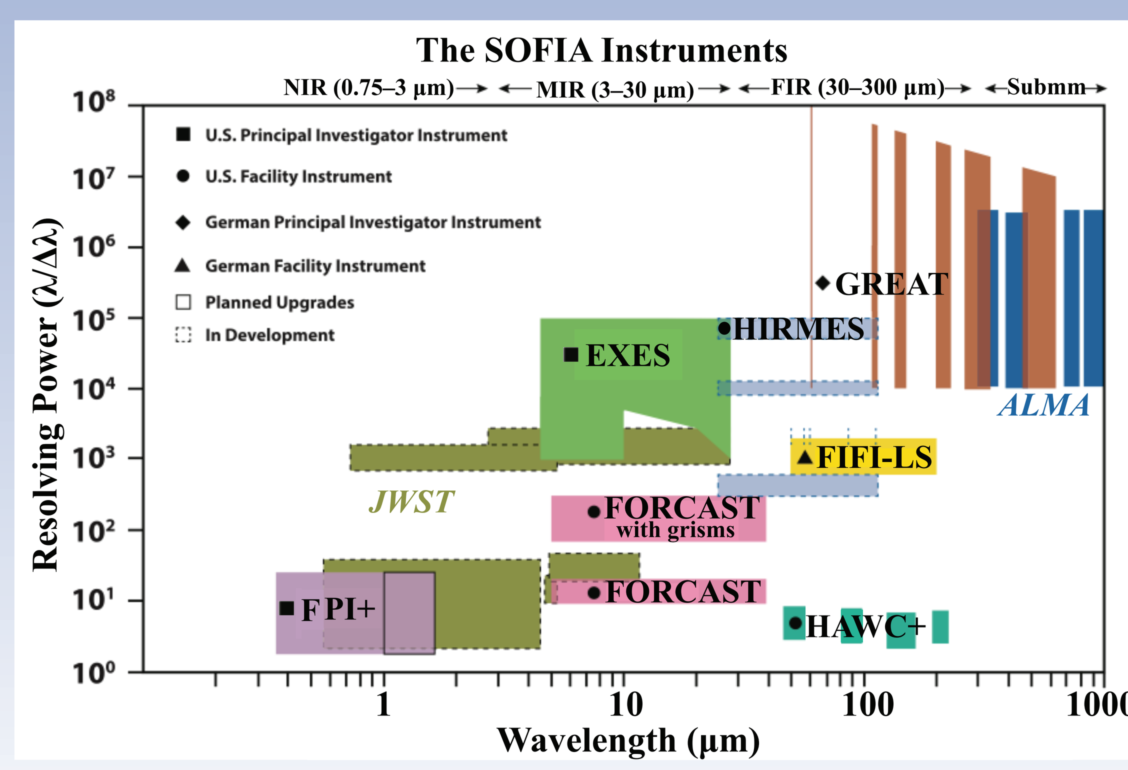
Overview

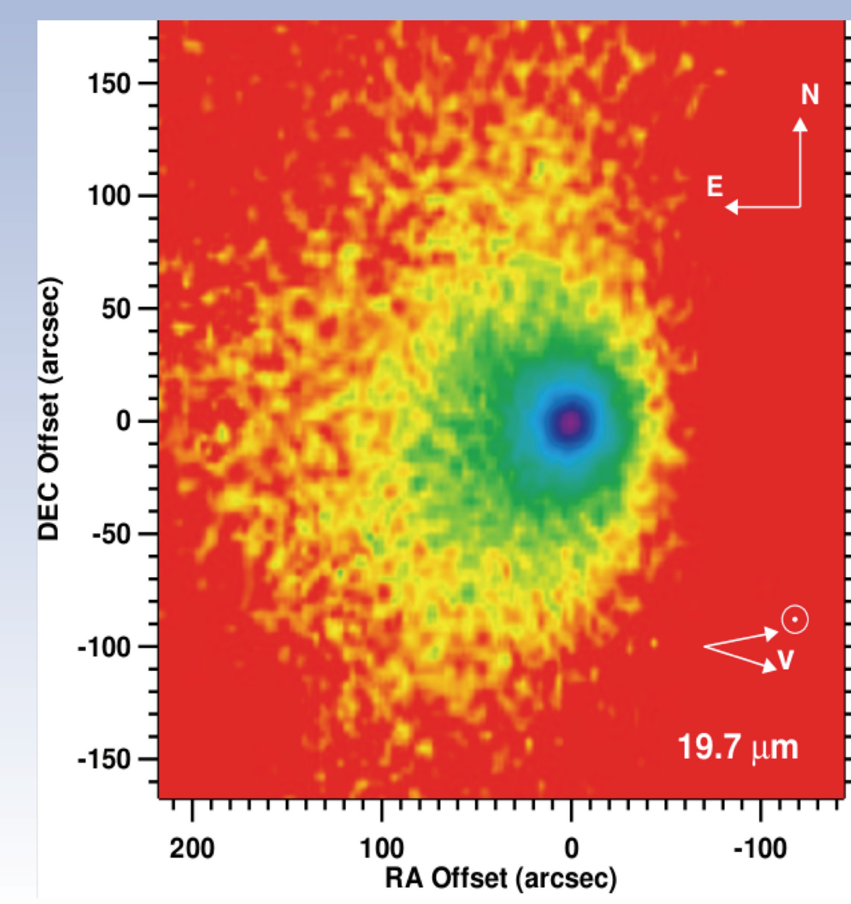
Now in its seventh cycle of observations, the wide instrument suite onboard the Stratospheric Observatory for Infrared Astronomy (SOFIA) has continued to offer a unique access to the far-IR sky in the 4-600 microns range. Thanks to its positioning flexibility, SOFIA has been instrumental in occultations observation campaigns. This poster highlights some of the latest SOFIA Solar System results.



Cometary Dust

Cometary dust: Low-resolution far-IR spectra of comae dust are a good diagnostic of **grain size distribution** and albedo. In the 5-40 microns region, signature bands of **silicates and carbonates** can also be evidenced. In addition to fractional composition (e.g., Fe:Mg ratio), **crystalline/ amorphous** nature can be determined.

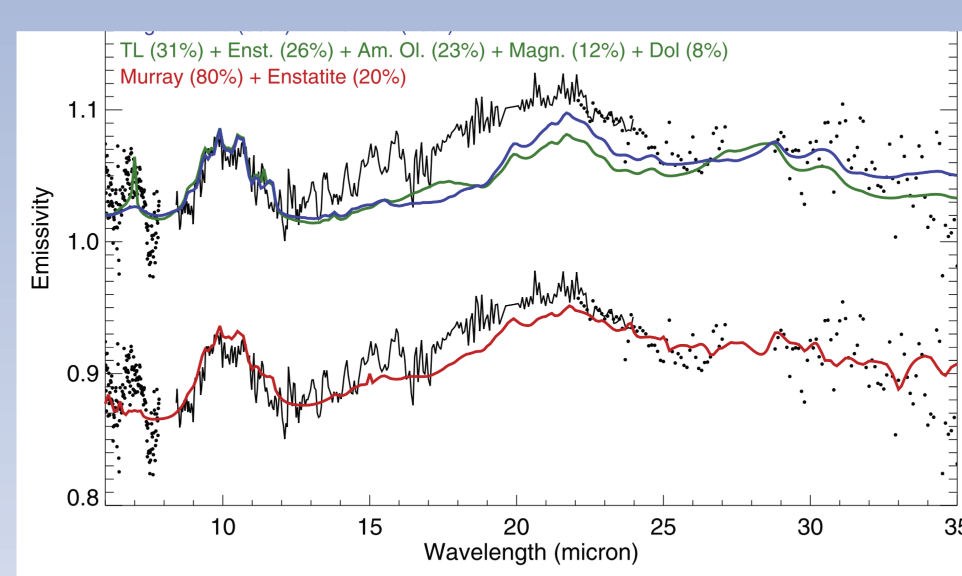
Information on the nature of dust grains, which are typically less processed than nuclei ices, can be directly related to characteristics of the early Solar System nebula.

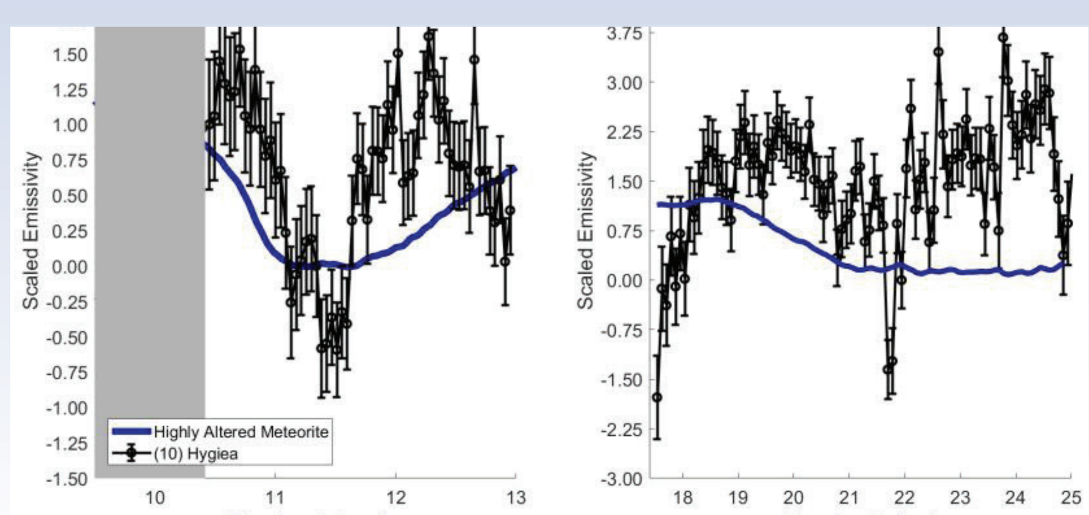


FORCAST image of comet PanStarrs. [1]

Surface Spectroscopy

Solid surfaces, in particular of low-thermal inertia (porous) asteroids, display far-IR signature bands of **main mineral groups and organics**. Spectral bands below 30 microns can be compared to reference meteoritic samples to identify links to parent bodies and exogenous material contributions [2]. Another area of focus is **phyllosilicates** fraction estimation, which, in combination to near-IR spectra, is used to assess the level of aqueous alteration which happened at the time of formation [3].



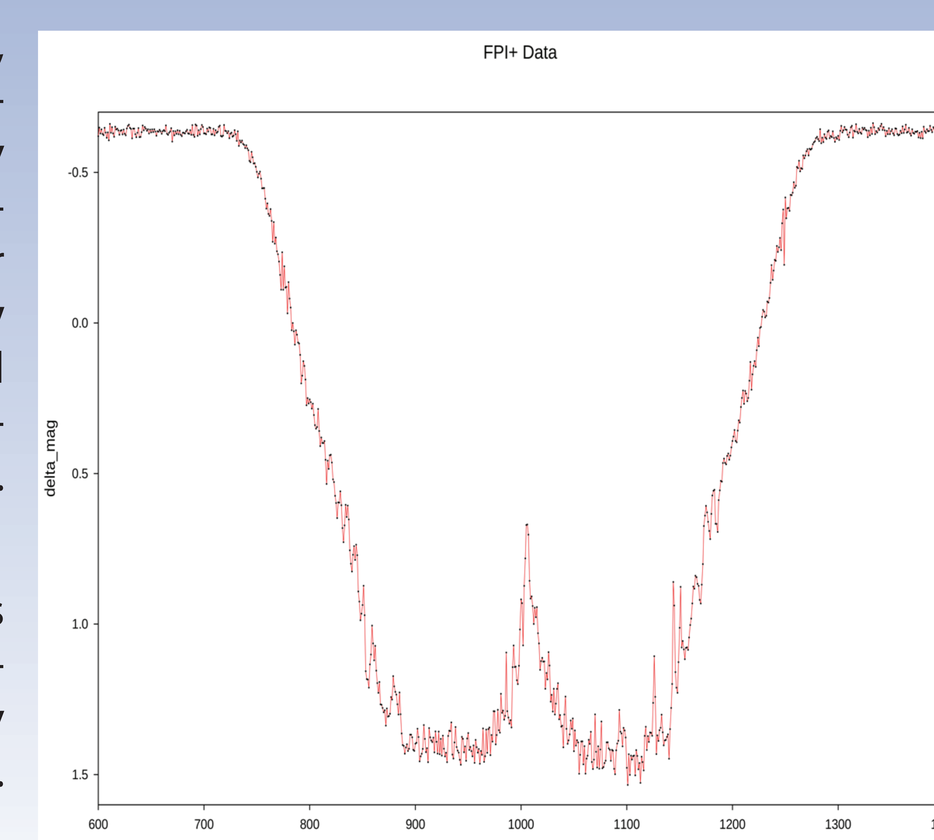


FORCAST emissivity spectra of Ceres (top, [2]) and asteroid Hygiea (bottom, [3]).

Occultations

Thanks to its positioning flexibility, SOFIA has been instrumental in observation campaigns of occultations by Triton, Titan, Pluto and smaller Kuiper-Belt objects. Such campaigns offer strong constraints on the **solid body size and shape**, pressure and thermal **atmospheric profiles**, and the vertical distribution of atmospheric **hazes**.

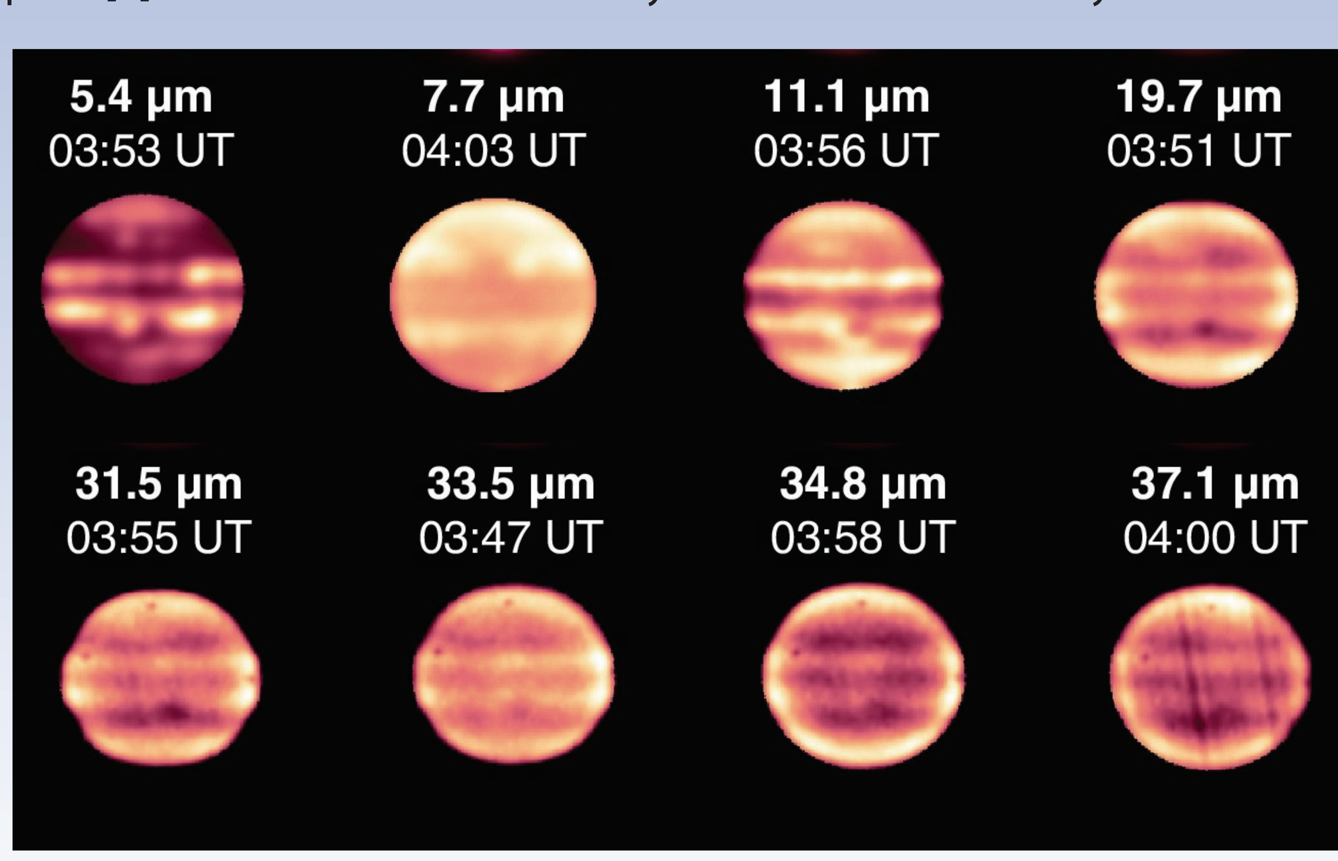
Optical camera FPI+ observations are most often preferred to be compared to ground-based cords, but any imaging instrument could be used.



FPI+ occultation lightcurve of Pluto, E. Pfueller

Atmospheric Dynamics on Giant Planets

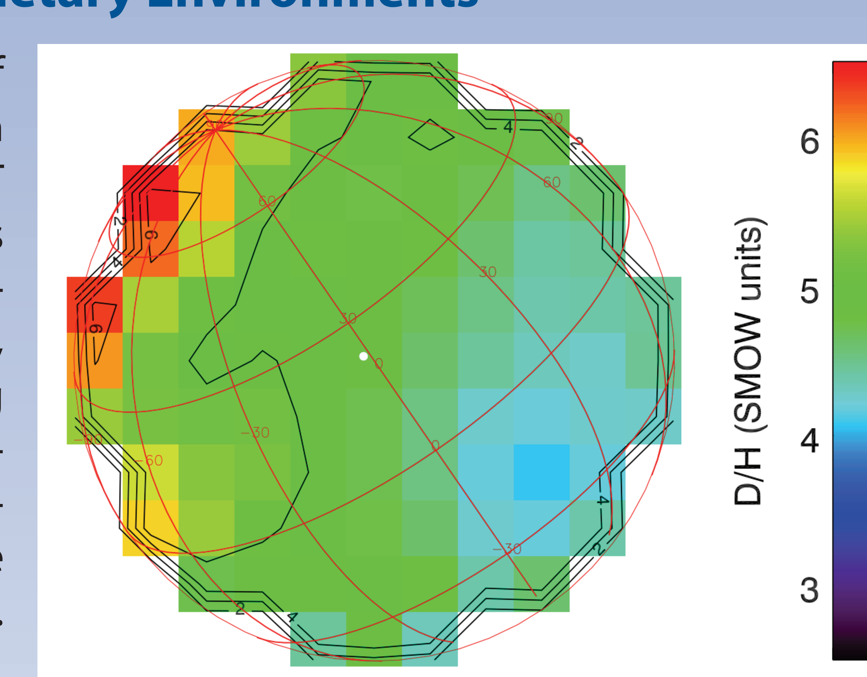
Giant planet's low-resolution spectra between 5-40 microns are diagnostic of the temperature in the upper troposphere (weather layer) and the ortho-para ratio in H2, tracing out-of equilibrium gas. Such constraints on large-scale weather are essential to building templates to interpret exoplanet spectra. On Jupiter, spectra can be mapped [5] to detect latitudinal asymmetries and identify local circulation cells.

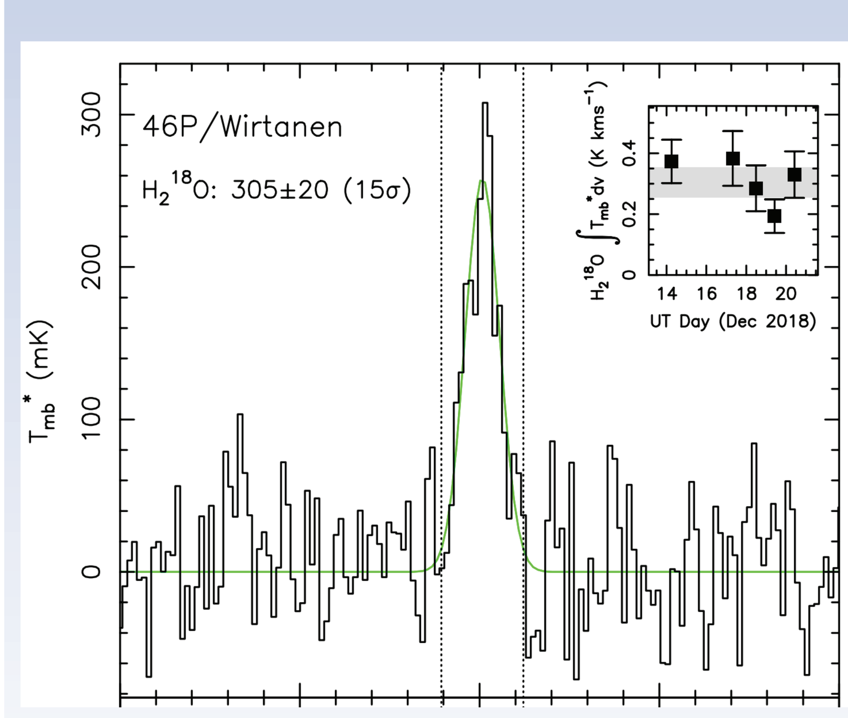


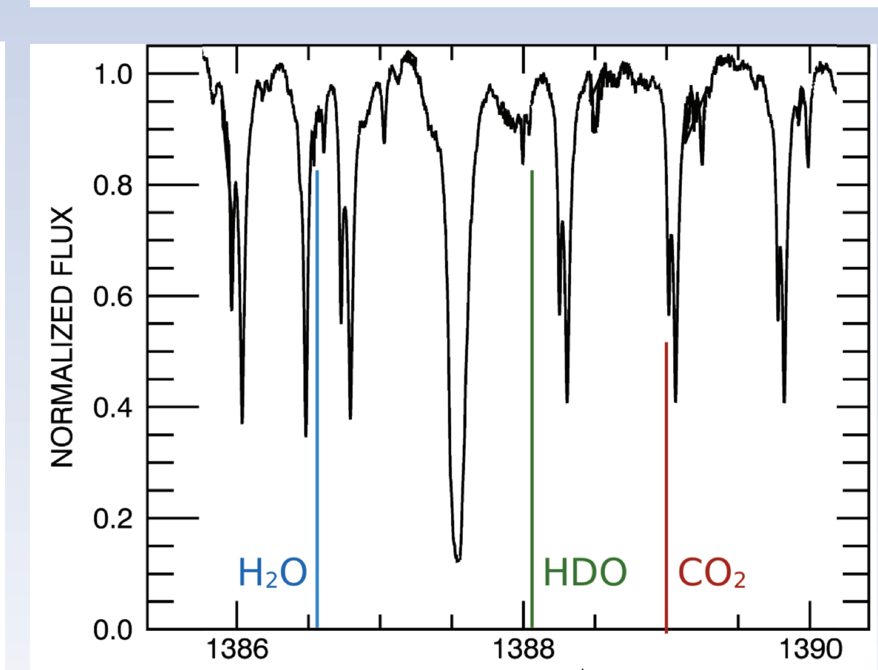
FORCAST images of Jupiter [5]

Composition of Atmospheres/Planetary Environments

In the far-IR range, direct identification of gas-phase molecules necessitates high spectral resolution. EXES, FIFI-LS and GREAT can resolve Q-branch ro-vibrational bands and rotational lines of common planetary and cometary components: **CO_2, CH_4, CH_3, H_2O, H_2O_2, HDO, SO_2, ...** allowing one to retrieve **column densities** and constrain **thermal profiles**. Atomic and ionized fine structure lines can be also be detected in planetary environments (tori).







Derived D/H ratio in water on Mars from EXES spectra (top) [4], Comet 46P/Wirtanen GREAT spectrom of H2O (bottom left) [6], and EXES specrum of Venus, courtesy of C. Tsang (bottom right).

References

[1] Woodward et al., ApJ 809, 2015 [2] Margaret McAdam, PhD thesis, University of Maryland, 2017 [3] Vernazza et al., AJ 153, 2017 [4] Encrenaz

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