HIRMES

High-resolution Mid-infrared Spectrometer for SOFIA

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with quotes from

PI Matt Greenhouse, the HIRMES homepage and

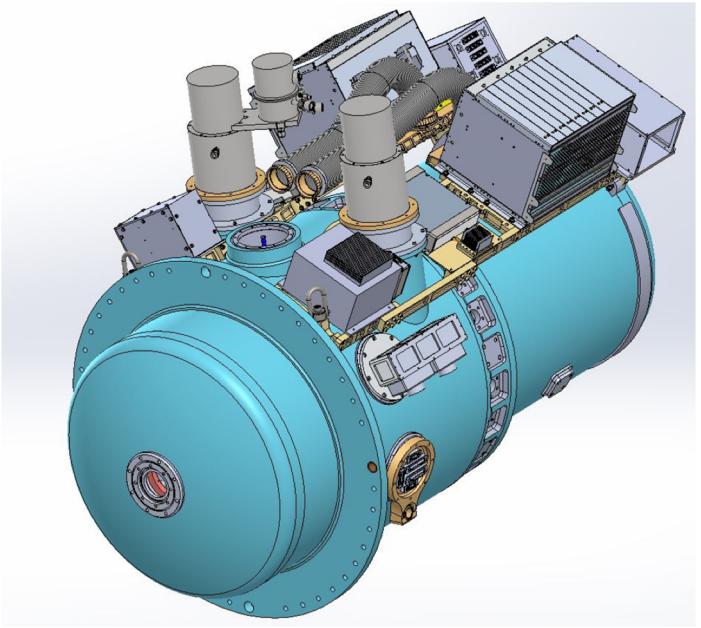
the NASA Director of Astrophysics Paul Hertz

HIRMES Technical Capabilities

- HIRMES is a direct detection spectrometer covering the 25 to 122 μm spectrum in 4 operating modes optimized to deliver the maximum sensitivity achievable with SOFIA:

  1. High resolution spectroscopy: 50,000 < $\lambda/\Delta\lambda$ < 100,000
  2. Medium resolution spectroscopy: $\lambda/\Delta\lambda$ ~ 10,000
  3. Low resolution spectroscopy: $\lambda/\Delta\lambda$ ~ 600
  4. Spectral Imaging: $\lambda/\Delta\lambda$ ~ 2000

- HIRMES is a SOFIA facility-class instrument that is designed for use by the general astronomical community in support of a wide-range of exoplanet, planetary science, and astrophysics investigations
- The instrument achieves these capabilities by utilizing direct-detection Transition Edge Sensor (TES) bolometer arrays, grating-dispersive spectroscopy, and Fabry-Perot tunable narrow-band filters.



HIRMES addresses important themes in exoplanet and planetary science

- The overarching science theme is the study of the composition and evolution of protoplanetary systems
- HIRMES is designed to address key questions about protoplanetary disks :
  - What are their masses?
  - How are gas, water vapor, water ice, and dust distributed?
  - How is neutral oxygen distributed?
  - What is the deuterium abundance of the giant planets?
  - What is the abundance of: deuterium, amorphous water ice, and crystalline water in comets?
- HIRMES will measure the most important molecular species needed to address these questions
  - **Water and ice:** gas-phase water and water-ice play a critical role in the formation of giant planet cores and, producing habitable conditions in terrestrial planets
    - H_2O 34.9823 μm 6_{51}-6_{24} rotational line
    - Ice 43, 47, 63 μm amorphous & crystalline solid state feature
  - **Neutral Oxygen:** a tracer of disk chemistry and radial structure
    - [OI] 63.1837 μm $^2P_1$-$^3P_2$ fine-structure line
  - **Deuterated hydrogen:** a tracer of disk mass
    - HD 112.0725 μm J = 1-0 rotational line
    - HDO, $H_2{}^{18}O$ 112.1 and 109.3 μm (comets)
- No similar capability has or will be enabled by the Orbital Program through 2030.

HIRMES Cancellation

- On 1st of April 2020 the development of HIRMES was terminated by the Director of the NASA Astrophysics Division.
- The technical, cost, and schedule risks of the project had grown to an extent that it was seen to significantly impact SOFIA's activities and its ability to increase scientific return.
- The accumulated cost development and delay showed that the project could not even be completed with a recently approved cost increase and was unlikely to be finished within schedule.
- The SOFIA project was directed to evaluate the options to provide enhanced instrument capabilities for SOFIA and recommend a roadmap by September 2020.
- The option of restarting the project once certain technological problems in detector development are better under control is not excluded.