Science, Required Technology, and Scope of a Probe-Class Far-Infrared Observatory

IR STIG Special Session
January 4, 2022

Jason Glenn, Goddard Space Flight Center
Matt Bradford, JPL
Far-IR Probe Science
The Obscured Universe

• Single ~2 m aperture
  ▪ SPIRIT provides an alternative concept for a FIR interferometer: not described this presentation but similar wavebands and detector NEPs as GEP
• Potential observational capabilities (GEP)
  ▪ Hyperspectral imaging 10 – 400 µm (mid-IR $\mathcal{R} \sim$20)
  ▪ Spectroscopy 24 – 193 µm ($\mathcal{R} \sim$200)
• History of star formation and SMBH growth in galaxies
• The growth of metallicity in the hearts of galaxies
• Physical conditions of interstellar and protostellar disk gas for star and planet formation
Far-IR Probe Required Technology

Arrays of several x10,000 low NEP detectors

The science is enabled by progress in array sizes and sensitivities. Key performance parameters must be demonstrated in the next 1 or 2 years.

Options: KIDs, TESs, QCDs.

Key parameters:
- Imaging: NEPs $\leq 10^{-18} \text{ W Hz}^{-1/2}$
- Spectroscopy: NEPs $< 10^{-19} \text{ W Hz}^{-1/2}$
- Efficient optical coupling down to 10 and 25 $\mu$m (imaging and spectroscopy)
- Dynamic range
- Robustness to cosmic rays

10 $\mu$m JPL KIDs (Day, LeDuc, Fyhrie, Perido, Glenn)
Far-IR Probe Scope

Budget cap $1.0B - $1.5B: GEP concept demonstrates scope

- Smaller aperture and/or more restricted instrumentation than afforded by Origins and SPICA: not all their science will be obtainable.

- Transformational astrophysics of galaxy evolution and star and planet formation will be possible with a cold aperture ($\leq 6$ K) and recent advances in detector sensitivity and array sizes.

- A fast community-wide effort to adapt and refine the Galaxy Evolution Probe, SPICA, and Origins science cases and optimize the FIR-Probe design needed to win the competition and ensure another 1 – 2 decades of exciting progress in our underexplored field.

Contact Jason and/or Matt to help shape this future!

jason.glenn@nasa.gov or matt.bradford@jpl.nasa.gov
Far-IR Probe Science Development Workshop
Monday March 21 - Wednesday March 23 (ending 1 PM)
Caltech Campus, Pasadena, CA
(With virtual component)

Objectives:
• Identify leading scientific questions for the Probe
• Outline measurement approaches and capabilities
• Chart final trades / decisions to guide formulation

https://www.ipac.caltech.edu/event/farirprobe
Questions: matt.brandon@jpl.nasa.gov, jason.glenn@nasa.gov