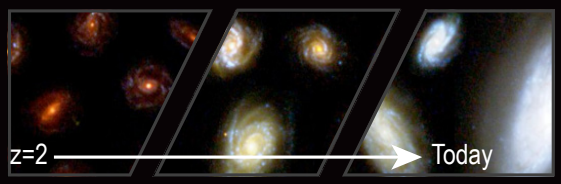
PRIMA

PRobe far-Infrared Mission for Astrophysics

PRIMA provides broad continuous spectral coverage from 24 to 261μm, a critical region of the spectrum that reveals the origins of planetary atmospheres, evolution of galactic ecosystems, and the buildup of dust and metals over cosmic time.

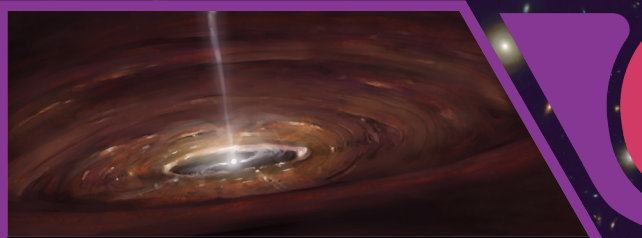
UNVEILING OUR COSMIC ORIGINS IN THE FAR INFRARED

Decadal Goal: Probe the co-evolution of galaxies and their supermassive black holes across cosmic time.

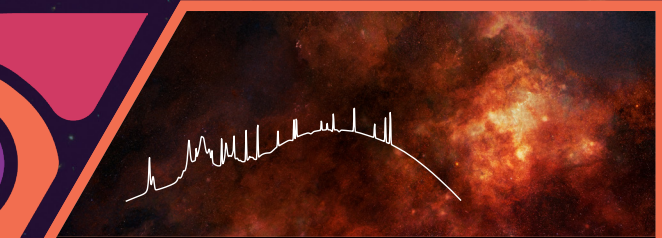


EVOLUTION OF GALACTIC ECOSYSTEMS

PRIMA Objective: Provide a simultaneous measurement of black hole and galaxy growth from the peak of their development at z=2 (cosmic noon) up to the present day, and determine if winds in luminous galaxies quench star formation.



Decadal Goal: Trace the astrochemical signatures of planet formation.



Decadal Goal: Measure the buildup of heavy elements and interstellar dust from early galaxies to today.

ORIGINS OF PLANETARY ATMOSPHERES

PRIMA Objective: Determine abundances in protoplanetary disks for comparison with exoplanet atmospheres and reveal whether water is essential to planet assembly.

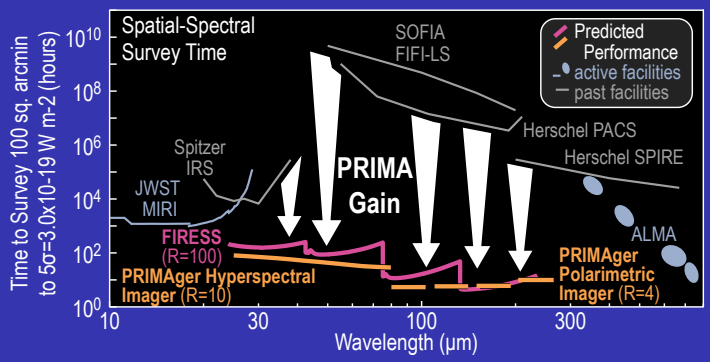
BUILDUP OF DUST AND METALS

PRIMA Objective: Compare the dust properties and metal content of dusty galaxies from cosmic noon to the present day and quantify the diversity of dust environments in the local universe.

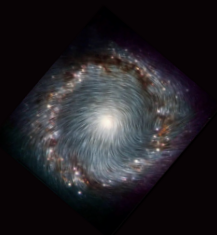
ALL PI-SCIENCE DATASETS WILL BE RAPIDLY AVAILABLE TO THE COMMUNITY

GENERAL OBSERVER SCIENCE

PRIMA's 3-5 orders of magnitude gain in spectral mapping speed unlocks science discovery space between JWST and ALMA. With 75% of observing time dedicated to GO science, PRIMA can obtain spectra of hundreds more protoplanetary disks, young stars, and distant galaxies than Herschel. See the PRIMA GO Science Book (https://arxiv.org/abs/2310.20572) for cases already identified by the community.

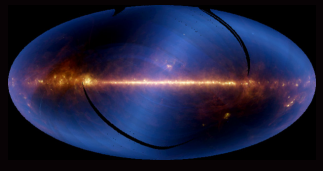


In 1200 hours: PRIMA can measure the D/H isotopic ratio of water in a statistically-significant sample of solar system comets - a key constraint to the origin of water on Earth



In 100 hours: PRIMA can map magnetic fields in the diffuse gas in many local galaxies, revealing their role in how star-forming clouds are born

In 5000 hours: PRIMA can survey the entire sky to a sensitivity 100x deeper than IRAS and Akari that would engender a legacy of discovery



PRIMA

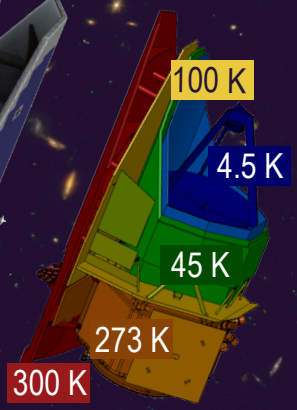
Mission Overview

Launch – June 2031

- AO standard LV & fairing
- Sun-Earth L2 (JWST)
- 5 years on orbit
- 25% PI, 75% GO science

Ball BCP Large Spacecraft

- <1 arcsec RMS pointing control
- ASI 2-axis gimbal and HGA support observations during communications
- Solar arrays sized to minimize cycling for ultra-stable thermal environment
- No cryo consumable



End-to-End Thermal System

- Multistage passive system building on Spitzer and Planck
- >100% margin on each thermal stage
- JWST MIRI flight spare cryocooler (4.5 K)
- Hitomi heritage Continuous Adiabatic Demagnetization Refrigerator (≤1 K)

Science Enabled by Sensitive Far-IR Detectors

Kinetic Inductance Detector (KID) Arrays – 0.1 K

- Enabling technology for FIRESS and PRIMAger
- Reaches fundamental photon background limit of solar system and galactic dust, with more than 10x better sensitivity per pixel than previous far-IR space missions
- More than 12,000 total pixels in 6 arrays (3-10 times more pixels than previous far-IR space missions)
- KIDs built at JPL and SRON with key contributions from GSFC

PRIMAger – Versatile Imager – 1 K

- Hyperspectral imaging (PHI): 24-84 μm with R=10
- Polarimetric imaging (PPI): 4 bands from 80-261 μm

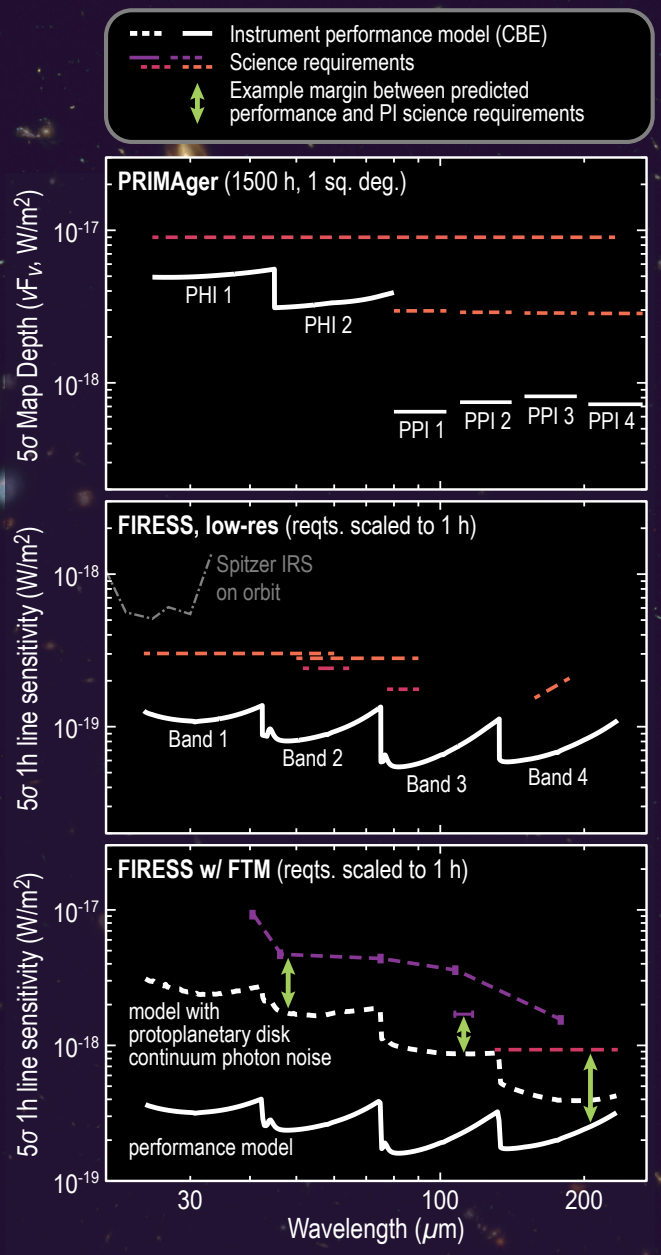
FIRESS – Multimode Survey Spectrometer – 1 K

- 24-235 μm spectral range at R>85
- More than 10x point source sensitivity improvement over previous missions, Herschel and SOFIA, and 1,000-100,000x improvement in spatial-spectral mapping speed.
- Dual polarization KID architecture provides best possible sensitivity.
- Slits overlap so that full spectrum is provided in 2 observations
- High-resolution mode with Fourier transform module (FTM) boosts R to more than 2,000 across the full band and 4,400 at 112 μm. Maximum R is 4,400 x (112 μm / λ)

1.8-m Telescope – 4.5 K

- All-aluminum telescope with 28-μm diffraction limit
- Enables astrophysical-background-limited observations
- Cryogenic 2-D steering mirrors with Herschel heritage provide fast, high-duty-cycle modulation for point source measurements as well as versatile mapping capability

KID arrays enable breakthrough science with both instruments. Image shows 1008-pixel FIRESS subarray under test.



PRIMA GO Science Book
https://arxiv.org/abs/2310.20572

PRIMA Website
https://prima.ipac.caltech.edu

PRIMA is a mission concept proposed to NASA. The information contained in this document is of a planning nature and is intended for informational purposes only. It does not constitute a commitment on the part of JPL, Caltech, and/or NASA.

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