

PRIMA *The PProbe far-Infrared Mission for Astrophysics*



GO and GI Science with PRIMA

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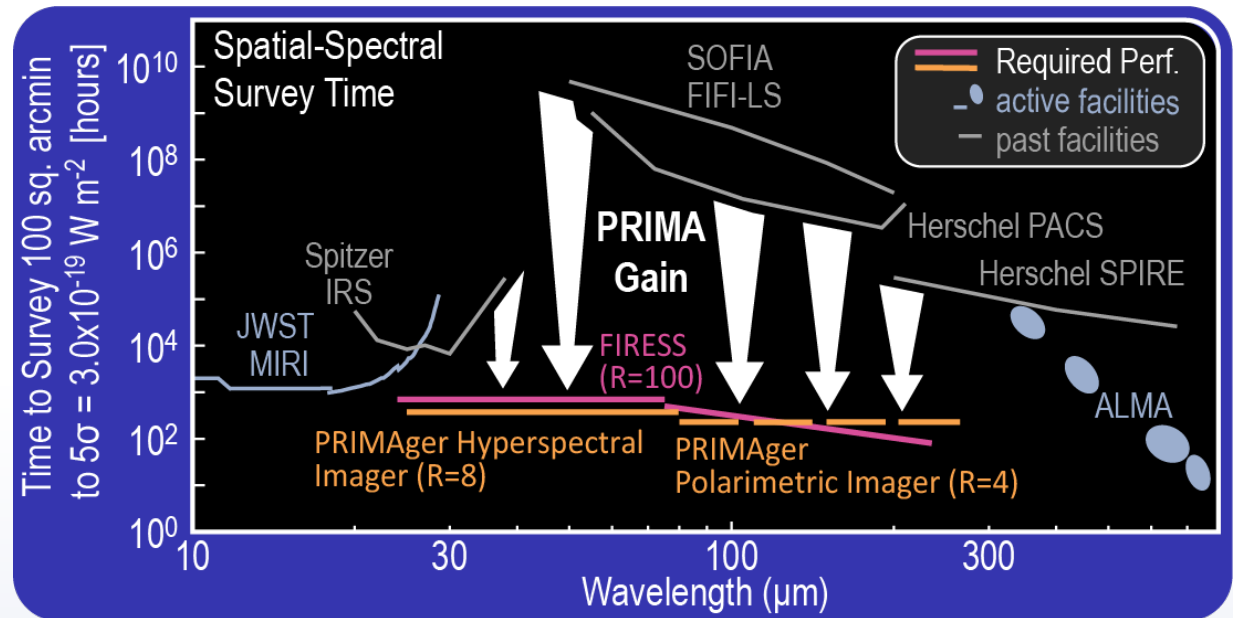
prima.ipac.caltech.edu



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sponsorship acknowledged.

PRIMA is designed primarily as community resource

- **75% of observing time for general observer (GO) programs**
-> ~32,000h over 5 years
- PI surveys producing high-impact legacy datasets for archival research (Guest Investigator [GI] science)
- Plan to archive PI surveys with access to all science and calibration data, software
- Most of PRIMA's scientific impact will come from community-led studies!



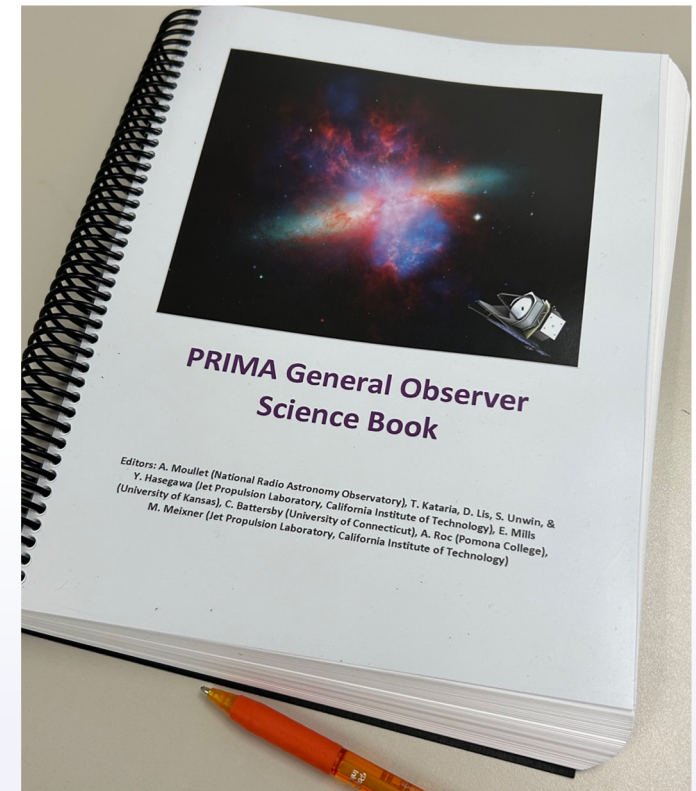
To develop a concept that is most responsive to community needs, PRIMA has continued to solicit community engagement in phase A

PRIMA GO Science Book Volume 1

PRIMA GO Book Vol. 1



- Volume 1 published on ArXiv in November 2023 (arXiv:2310.20572)
- Collection of **76** community-contributed cases, spanning scientific areas from comets to high-z polarimetry



PRIMA GO Science Book Volume 2: Now in press!

PRIMA GO Book Vol. 1

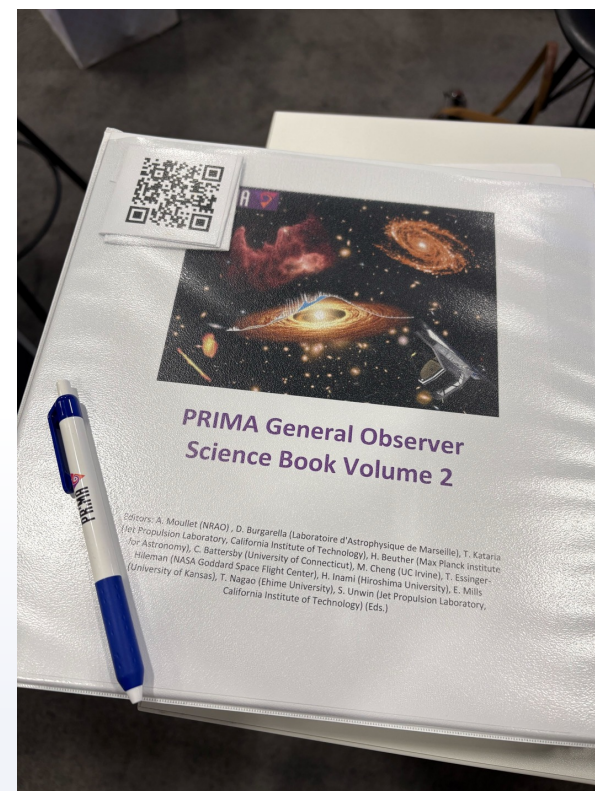


Moulet et al. 2023
76 GO cases

PRIMA GO Book Vol. 2



Moulet et al. 2025
120 GO cases





PRIMA JATIS Special Issue

PRIMA GO Book Vol. 1



Moulet et al. 2023
76 GO cases

PRIMA GO Book Vol. 2



Moulet et al. 2025
120 GO cases

PRIMA JATIS Special Issue



Rangwala & Griffin 2025
29 GO cases



BIG THANKS to our WG leads and members for their leadership and submissions!

AGN Across Cosmic Time

Sylvain Veilleux (University of Maryland)

Cosmic Ecosystems

Rebecca Levy (Space Telescope Science Institute)

Galaxy Evolution from Cosmic Dawn to Cosmic Noon

Irene Shivaiei (Centro de Astrobiología, Madrid)

Jed McKinney (University of Texas at Austin)

Mapping Magnetic Fields in the Local Universe

Enrique Lopez Rodriguez (University of South Carolina)

Kate Pattle (University College London)

Milky Way Interstellar Medium and Star Formation

Frédérique Motte (IPAG, CNRS, Univ Grenoble Alpes)

Dylan Paré (Villanova University)

Yao-Lun Yang (Star and Planet Formation Laboratory, RIKEN, Japan)

Protoplanetary Disks and Exoplanets

Andrea Banzatti (Texas State University)

Ke Zhang (University of Wisconsin)

Debris Disks

Meredith MacGregor (Johns Hopkins University)

Christine Chen (Space Telescope Science Institute)

Solar System and Planetary Science

Dariusz Lis (Jet Propulsion Laboratory)

Stars and Stellar Evolution

Olivia Jones (Royal Observatory, Edinburgh)

Sundar Srinivasan (Institute of Radio Astronomy and Astrophysics, National Autonomous University of Mexico)

Time Domain and Transients

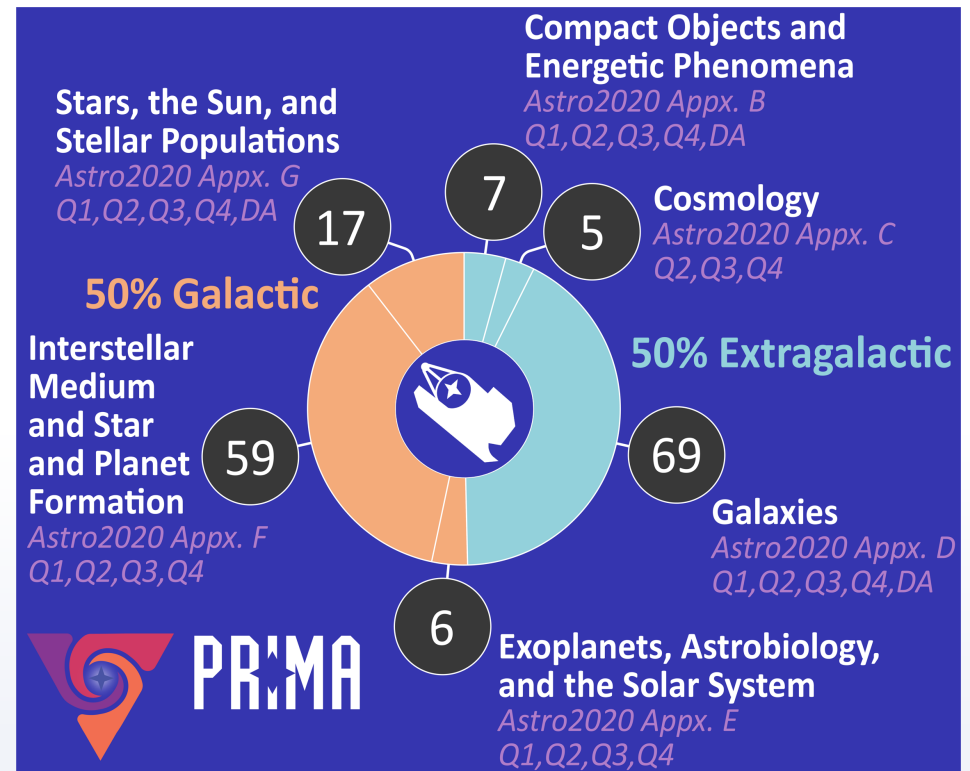
Mansi Kasliwal (California Institute of Technology)

Kishalay De (Columbia University)

PRIMA GO Books Vol. 1 and Vol. 2 by the numbers:

- **170** unique cases
- Over **60,000 h** of observations
- Cases address **>90%** of Astro2020 science questions

Observing Mode	% of cases
FIRESS high-resolution pointed spectroscopy	23%
FIRESS low-resolution pointed spectroscopy	25%
FIRESS low-resolution spectral mapping	19%
PRIMAger scan mapping (PHI)	27%
PRIMAger multiband imaging (PPI)	33%





PRIMA GO Books Vol. 1 and Vol. 2 example cases

Observing Mode	% of cases	Potential GO Case
FIRESS high-resolution pointed spectroscopy	23%	Constrain late accretion stage of water delivery via measuring D/H ratio in solar system comets (Lis et al. 2025)
FIRESS low-resolution pointed spectroscopy	25%	Constrain mineralogy of dust produced in evolved stars (Kemper et al. 2023)
FIRESS low-resolution spectral mapping	19%	Determine elemental abundances in obscured HII regions (Pineda et al. 2025)
PRIMAger scan mapping (PHI)	27%	Resolve the Cosmic Infrared Background by studying highly lensed sources (Hatsukade 2025)
PRIMAger multiband imaging (PPI)	33%	Probe dust porosity in protoplanetary disks (Pattle et al. 2023)

Conclusions

PRIMA's Phase A selection was possible thanks to strong community support.

THANK YOU!

Ways to connect:

- PRIMA newsletter
- P-CAST
- **Film a PRIMA testimonial!**



Film a PRIMA testimonial!

- The PRIMA team will be filming short testimonials today at **3:30-5:00pm** in an alcove outside the exhibit hall (turn left when you exit the hall).
- We'd love to hear why the far-infrared is important for your science, and what excites you most about PRIMA.
- Come to our PRIMA social hour at Barrel & Bushel inside the Hyatt Regency Phoenix (122 N. 2 Street) **tonight at 6:45pm**. Please join us!



The graphic is a white rectangular box with a thin black border. At the top center is the PRIMA logo, which consists of a stylized 'P' made of two overlapping triangles (one purple, one orange) and the word 'PRIMA' in a bold, black, sans-serif font. Below the logo, the text 'filming here!' is written in a black, sans-serif font. In the center of the box is a red rectangular area. Inside this red area, at the top, is the text 'Keep up with PRIMA!'. Below this text are four QR codes arranged in a row. Above each QR code is a small label: 'Sign up for the PRIMA mailing list', 'PRIMA GO Book Vol. 1', 'PRIMA GO Book Vol. 2', and 'PRIMA JATIS Special Issue'. To the right of the QR codes, there is a small text block that reads: 'Record a PRIMA testimonial! Excited about PRIMA? Visit us at the PRIMA booth to tell us why you're excited about PRIMA and how it would advance your science. We want to hear from you!'. At the bottom of the red area is a blue rectangular button with the text 'Visit us at: prima.ipac.caltech.edu'.

PRIMA

filming here!

Keep up with PRIMA!

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PRIMA GO Book Vol. 1

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Additional slides



Become a working group member

During proposal development, topical working groups (WGs) provided input to PRIMA science

- For Phase A, we now invite the community (any career stage!) to sign up to WGs, meetings resume February
- Opportunity to work closely with the PRIMA team to determine PRIMA's impact to your science
- WG members can contribute by defining **precursor studies**: simulations and observations laying the groundwork for PRIMA science.



Working group sign-up

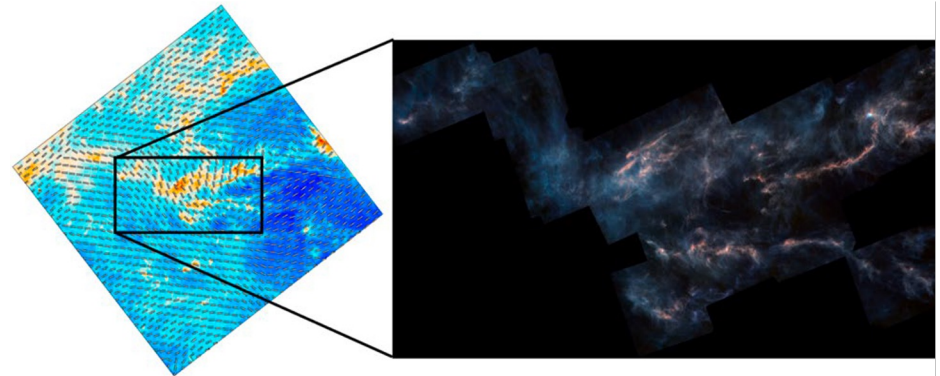
We strongly encourage early career participation in WGs!



In PRIMA GO Science Book Volume 1: Magnetic Fields

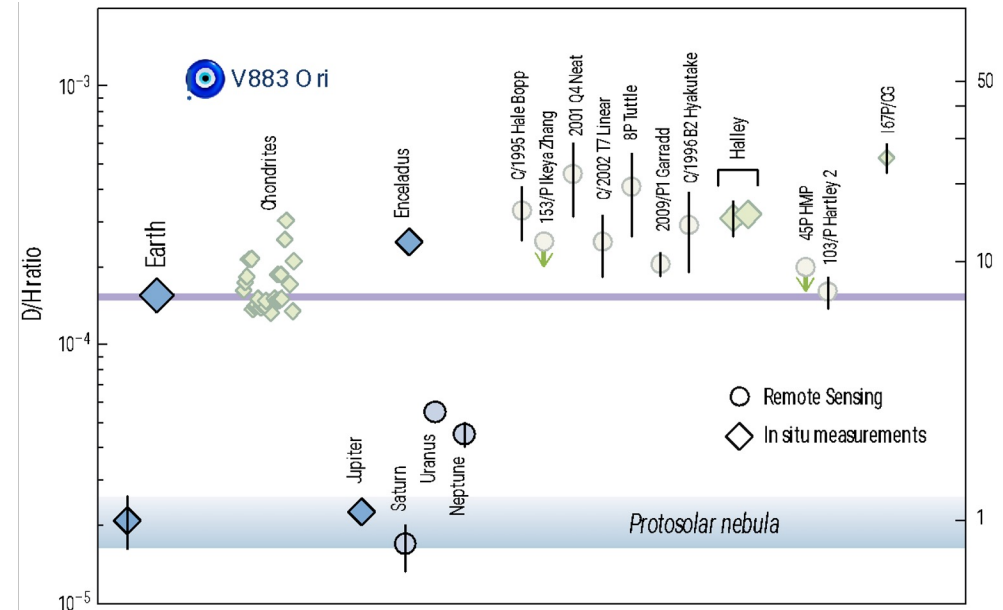
- In 1000 hours, a 160 sq degree area can be mapped to survey the magnetic field distribution of all **star-forming regions within 0.5 kpc**, allowing to connect the all-sky Planck maps to the structure within individual star-forming filaments and cores. (Pattle et al. 2023).
- In 5 h, magnetic fields can be mapped in a sample of **evolved stars environments** (Planetary nebulae, Symbiotic Stars, WR, SN remnants), providing unique information on the interaction between magnetic fields and stellar winds (Sabin et al., 2023)

Pattle et al., 2023: The Taurus Molecular Cloud by Planck (Planck Collaboration 2015), and column density structure on ~10 arcsecond scales at the resolution of PRIMA (right; ESA/Herschel/NASA/JPL-Caltech; R. Hurt).



In PRIMA GO Science Book Volume 1: Transients

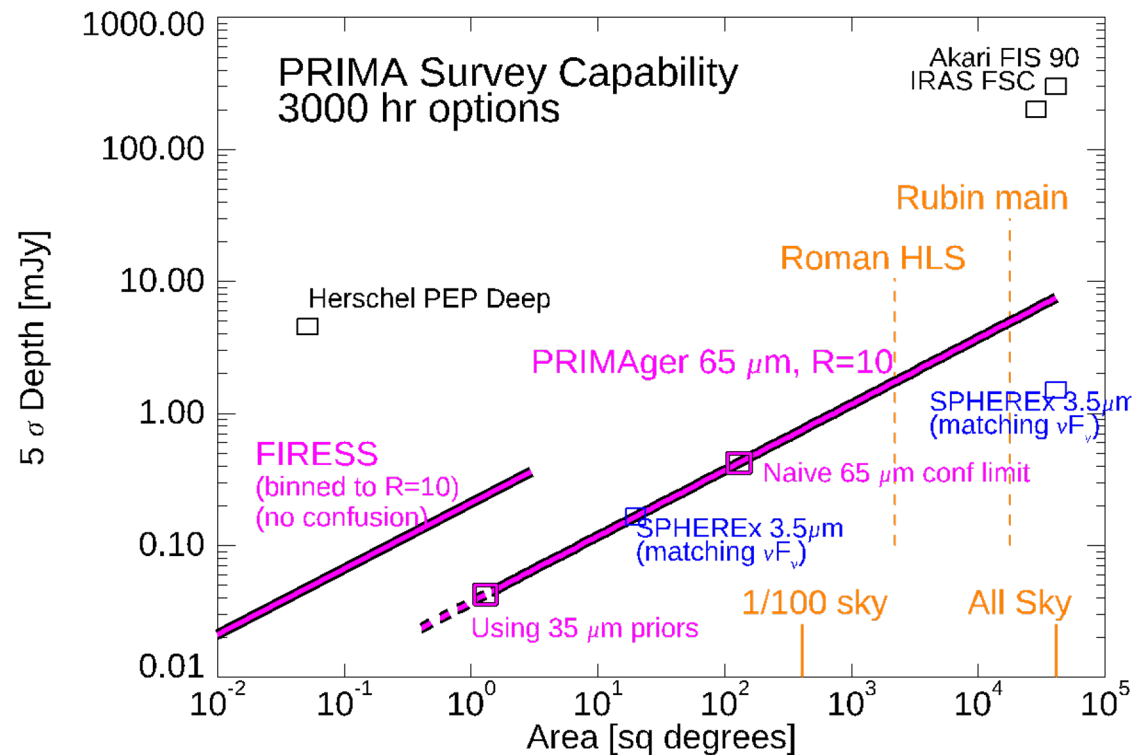
- In 20 minutes, the first far-infrared dust reverberation mapping study by monitoring one **AGN torus** at over the 5-year long mission: relation between SMBH accretion rate and disk clumpiness (Gorjian et al., 2023)
- In 5 minutes, detect **transient sources discovered by CMB experiments**, enabling efficient monitoring of hundreds of sources over day to week timescales (Clements et al., 2023)
- In 1,200 hours, measure the D/H isotopic ratio in water in ~30 **Solar system comets** to determine how, when, and in what quantity comets contributed to the Earth's water content (Lis et al., 2023)



Lis et al., 2023: D/H ratio in water in the Solar System (from the Origins Mission Concept Study Report after Altwegg et al. 2015). The blue disk marks the first ALMA measurement in the V883 Ori disk (Tobin et al. 2023).

Potential PRIMA GO investigations: Large Surveys

- PRIMA has high efficiency map modes provided by both observatory scan and the steering mirrors.
- In 5,000 hours, **an all-sky survey** can reach a depth comparable to Herschel extragalactic deep fields or sensitivity 100x better than the Infrared Astronomical Satellite (IRAS) all-sky survey (Wright et al., 2023)
- In 500 hours, a 200 square degree area of the **Small and Large Magellanic Clouds** can reach a sensitivity that allows separation of their dust emission from the Milky Way foreground and the Cosmic Infrared Background. (Galliano et al., 2023)

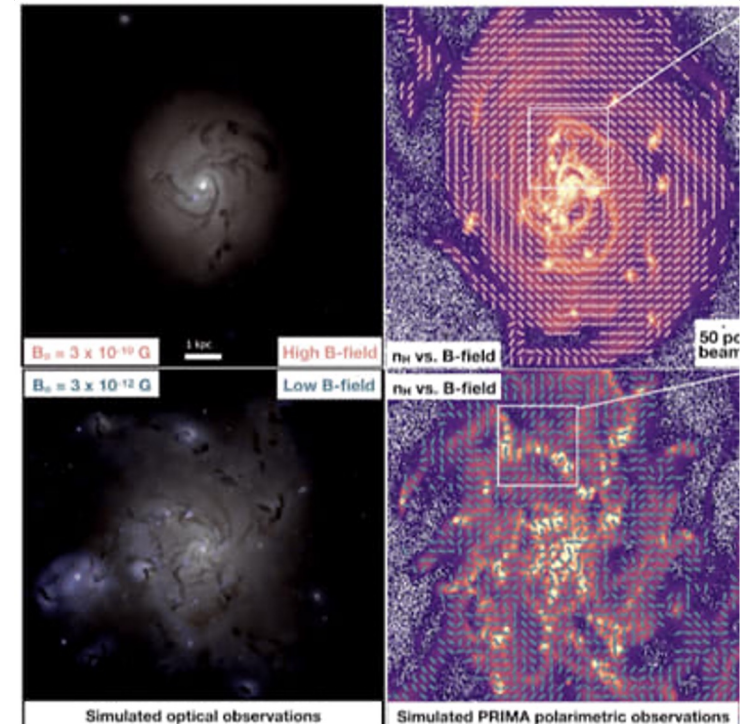




Potential PRIMA GO investigations: Magnetic Fields

- In 400 hours, an **extragalactic polarization survey** (400 sq degrees) to detect 10,000 galaxies at $z < 2$ to verify coherent large-scale B-field. Any local correlations in orientation? (Bethérmin et al., 2023)
- In 100 h, **magnetic fields in giant molecular clouds** can be mapped in 6 local galaxies at < 100 pc spatial resolution: information about collapse and regulation of star formation (Lopez Rodriguez et al., 2023)

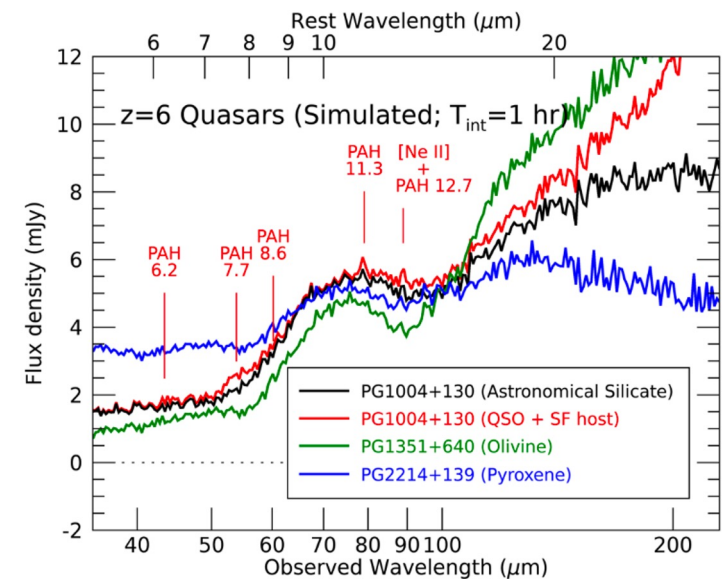
Lopez Rodriguez et al., 2023: Simulated optical and FIR polarimetric observations of a face-on view of a MW-like galaxy. High (top) and low (bottom) magnetization at 50 pc resolution.





Potential PRIMA GO investigations: Dust Mineralogy

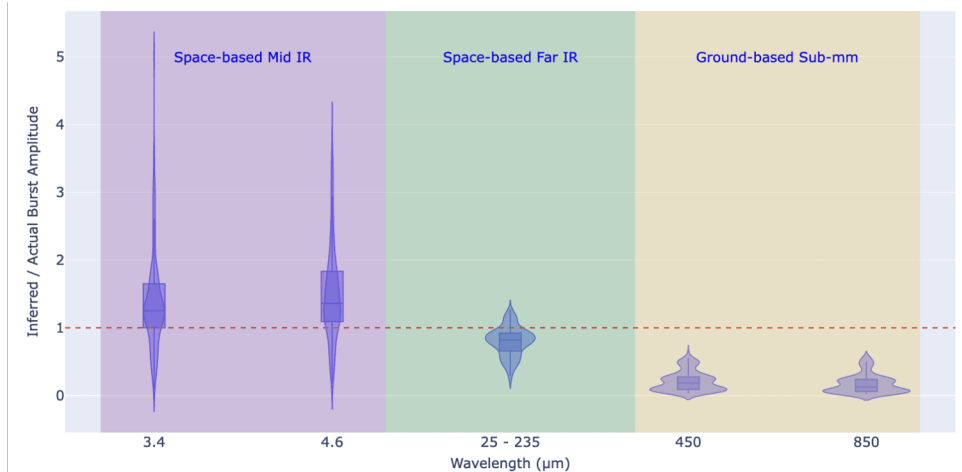
- **Dust formation at epoch of reionization:** In 1 h per target, obtain spectra of quasars at $z > 5$ – epoch of reionization – to constrain dust formation mechanisms: AGB stars, supernovae, ISM grains growth (Egami et al., 2023)
- Measure the crystalline silicate content on **star forming galaxies at $1.5 < z < 4$ (~ 1 h/source)** to characterize the dust formation in mass-losing stars, around cosmic noon (Kemper et al., 2023)
- In 10h, obtain a spectrum of dust in **supernovae** to evaluate mass and composition of dust created (MgSiO_3 , FeO , SiO_2 , FeS , Al_2O_3) and its contribution to ISM (Matsuura et al., 2023)



Egami et al., 2023: Simulated PRIMA/FIRESS low-resolution ($R=130$) spectra of quasars at $z=6$ ($T_{\text{int}}=1\text{hr}$)

Potential PRIMA GO investigations: Time Domain and Transients

- In 600 hours, PRIMA can monitor 2,000 protostars over the mission's lifetime with a range of revisit timescales, to obtain the first well-sampled, systematic study of **protostellar accretion variability**. The goal is to determine the frequency and types of bursts that protostars undergo (Battersby et al., 2023)
- In 5 minutes, detect **transient sources discovered by CMB experiments**, enabling efficient monitoring of hundreds of sources over day to week timescales (Clements et al., 2023)

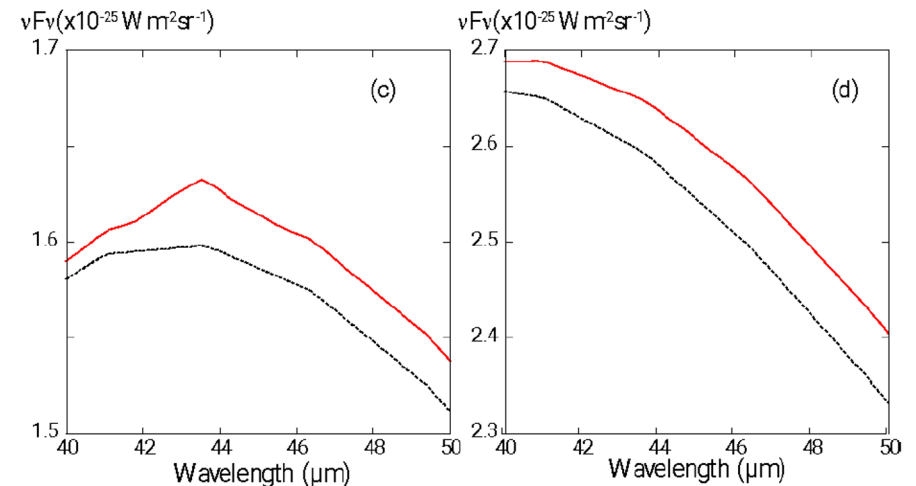


From Fischer et al., 2023: Ratio of inferred to actual burst amplitude for bursts in 86 Class 0 protostars. Far-IR is the only wavelength sensitive to the amount of mass being accreted onto a protostar during an accretion event



More potential GO science with PRIMA ...

- **ISM chemistry:** FIRESS can perform fast mapping of Milky Way ISM. Integration times to detect the bright fine-structure transitions (CII, OI, OIII, NII) are seconds, so several tens of square degrees of the Galaxy could be envisioned.
- Can also use ISM spectra can assess the presence of large ($>1 \mu\text{m}$) water ice grains, which could be the missing reservoir for oxygen (Onaka et al., 2023)
- **ISM evolution:** In 60 hours, map ~ 25 regions at the interface of AGB/PNEs circumstellar shells and ISM, to explore mechanisms for ISM seeding through stellar winds (Ueta et al., 2023)
- **Circumgalactic medium:** In 75 hours, detect the CGM in emission through fine-structure lines to constrain cooling rate (Tarantino et al., 2023)



Onaka et al, 2023 : (Left) Expected FIR emission with (red) and without (black) crystalline water ice grains of $5 \mu\text{m}$; (Right) Expected FIR emission with and without amorphous water ice grains of $2 \mu\text{m}$



PRIMA

Exposure Time Calculator

<https://prima.ipac.caltech.edu/page/etc-calc>



ETC Walkthrough

- Choose your instrument
- If FIRESS...
 - Choose your mode
 - Low-res point source → Specify line flux
 - Low-res mapping → specify wavelength, survey area, survey depth
 - High-res point source → specify wavelength, continuum flux density, line flux
- If PRIMAgger...
 - Choose your mode (Hyperspectral or Polarimetric)
 - For either mode, provide
 - Survey Area
 - Survey Depth



For suspected bugs, please contact John Arballo
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For other questions or comments, please contact Margaret Meixner
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