ExoSystem Reconnaissance: Warm Dust and Giant Planets

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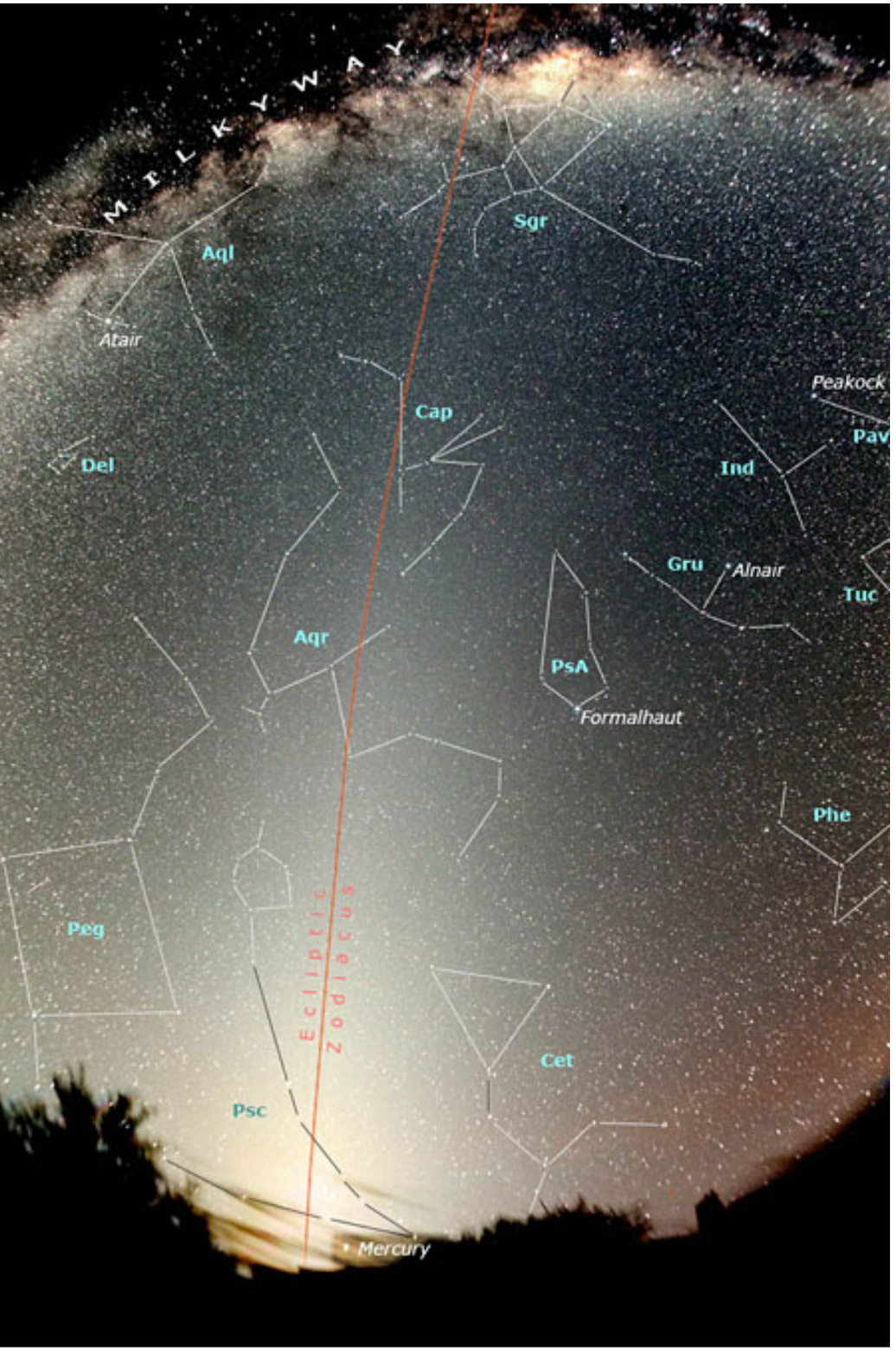
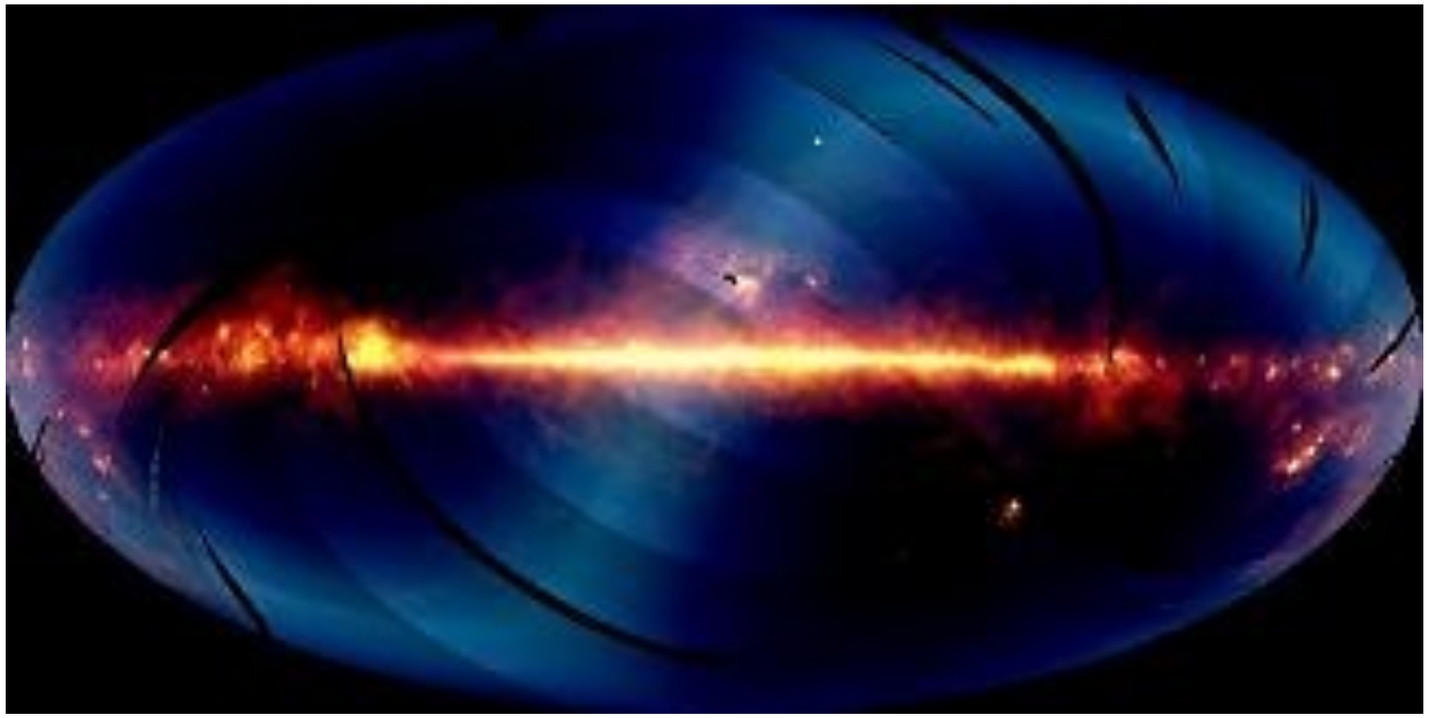
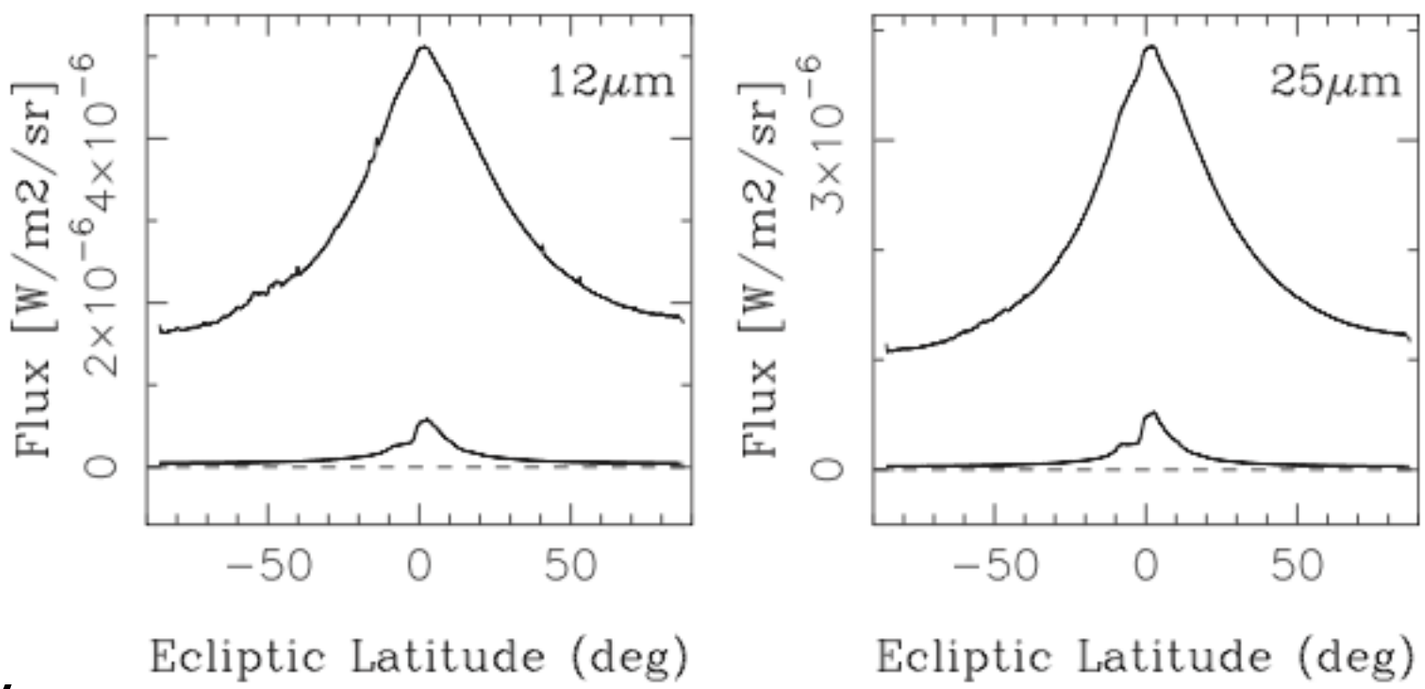
Zodiacal Dust







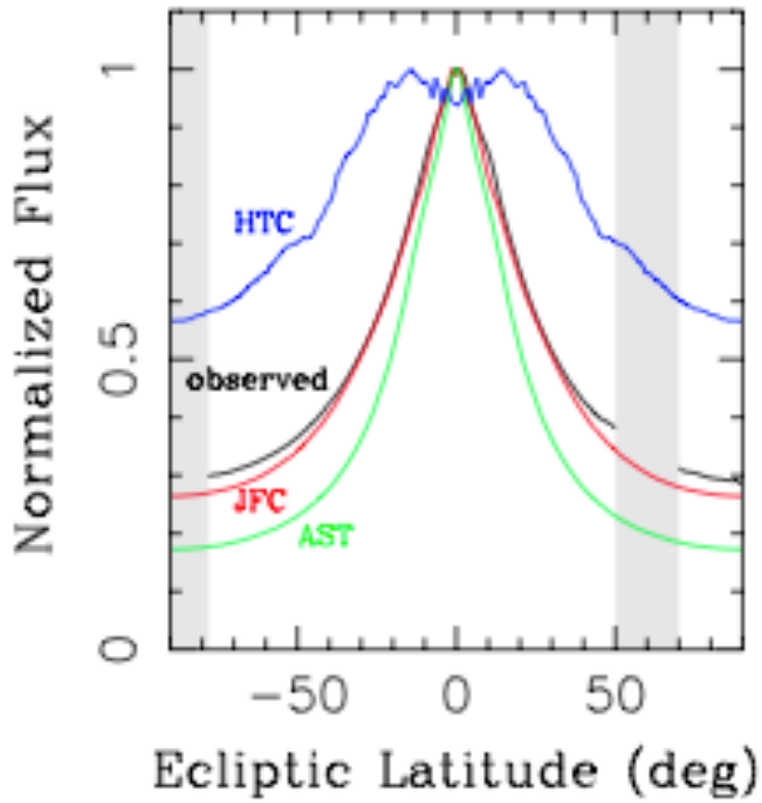
- Scattered light in ecliptic plane.
- Infrared emission first seen by IRAS.

from Nesvorney et al. 2010

Origin of Zodiacal Dust

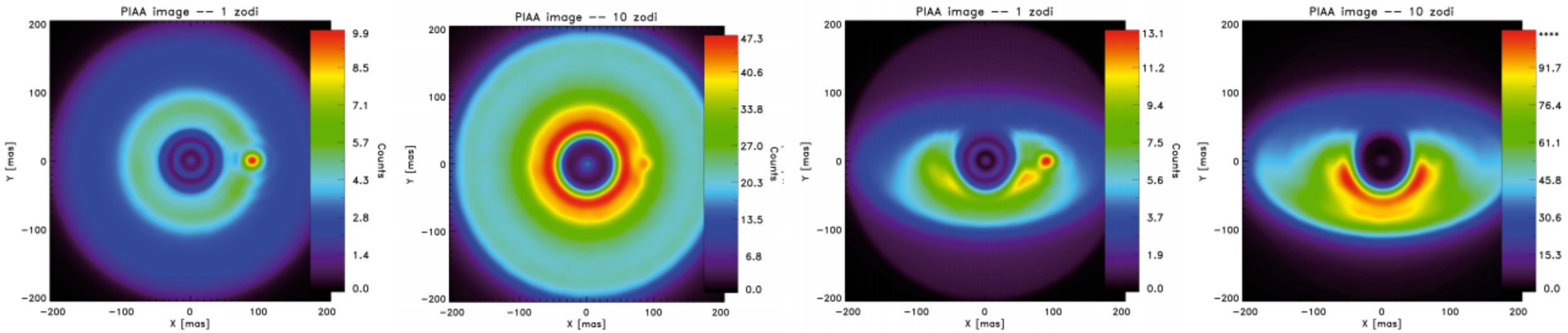
- Asteroid belt thought to provide much of the dust seen at Earth (Dermott et al. 2002).

- Recent Dynamical models (cf. Nesvorney et al. 2010) suggest Jupiter-family comets provide the majority of the dust for the zodiacal cloud.



from Nesvorney et al. 2010

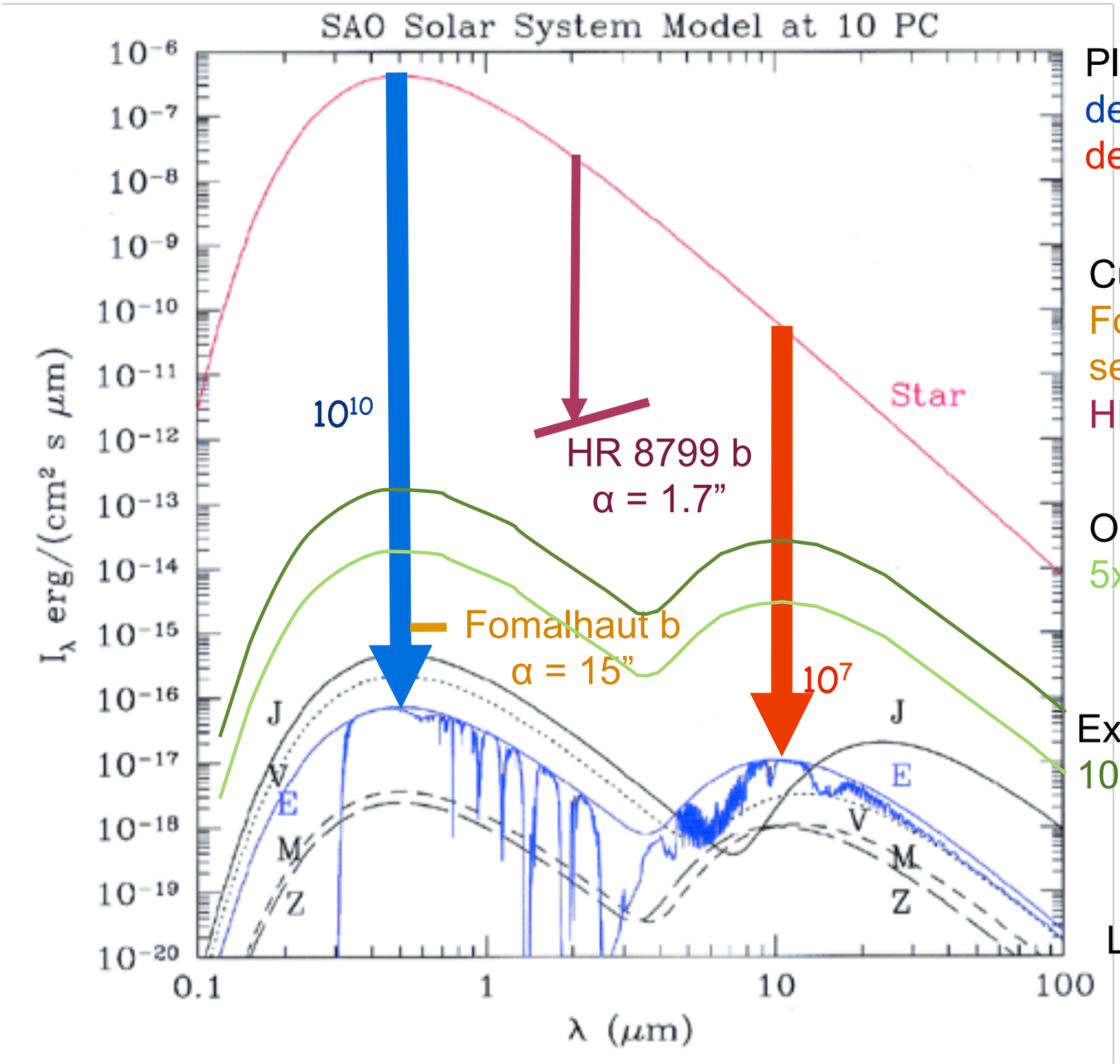
The problem with exozodiacal dust



from Defrere et al. 2012

- Flux is problematic for any imaging mission.
- Clumpiness (resonances) complicates the detection.

The Contrast Problem



Planet Finding missions aim to:
detect Earths 10^{-10} fainter in visible.
detect Earth 10^{-7} in the IR.

Current state of the art:
Fomalhaut b: 10^{-9}, but 150x separation.
HR 8799b: 10^{-4} but 17x separation.

Our own Zodiacal dust:
5×10^{-5} at 10 μm =1 zody.

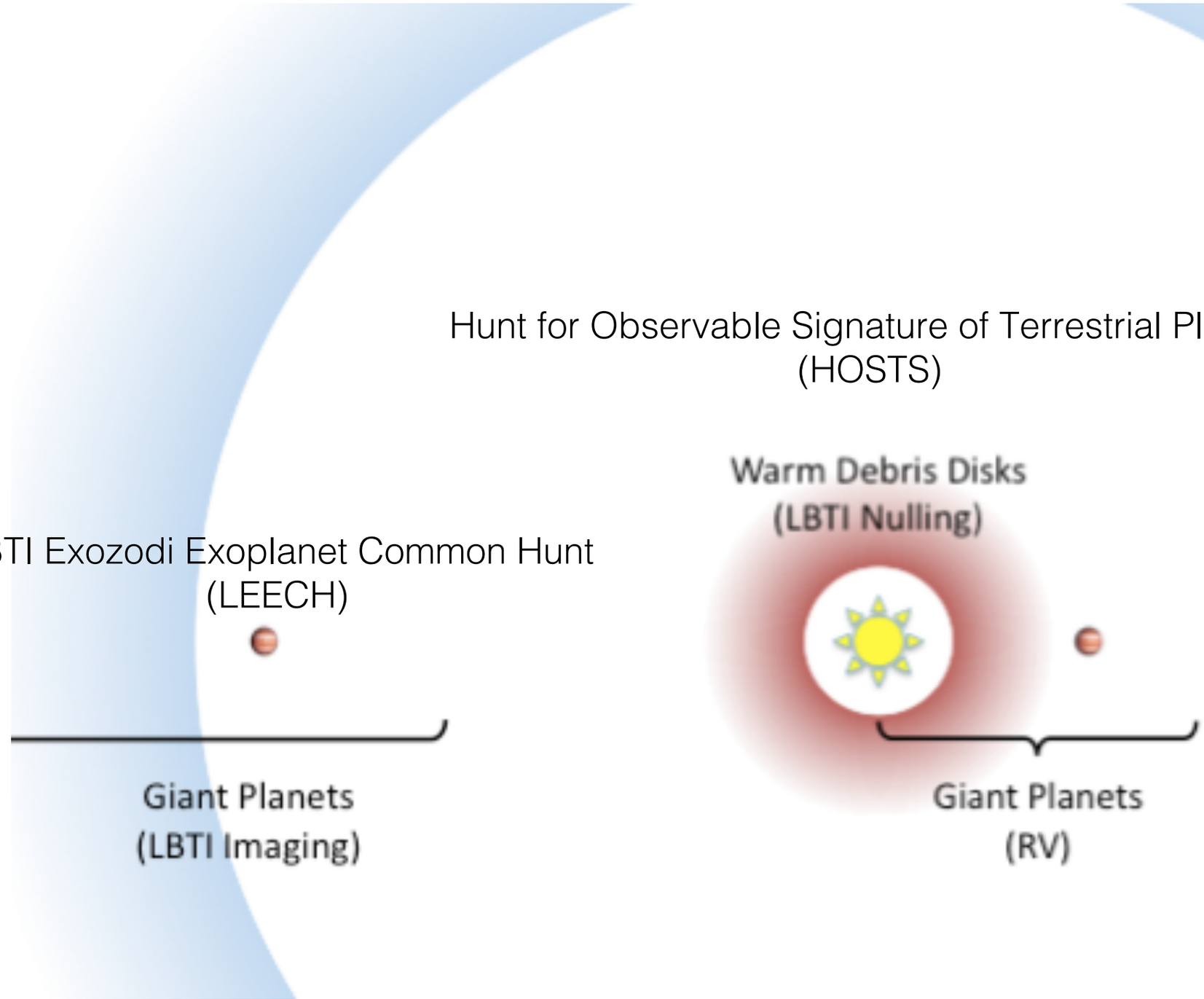
Exozodiacal dust becomes a problem:
10 zody or above.

LBTI can show us what exists (planets or dust disks) at faint levels around nearby stars.

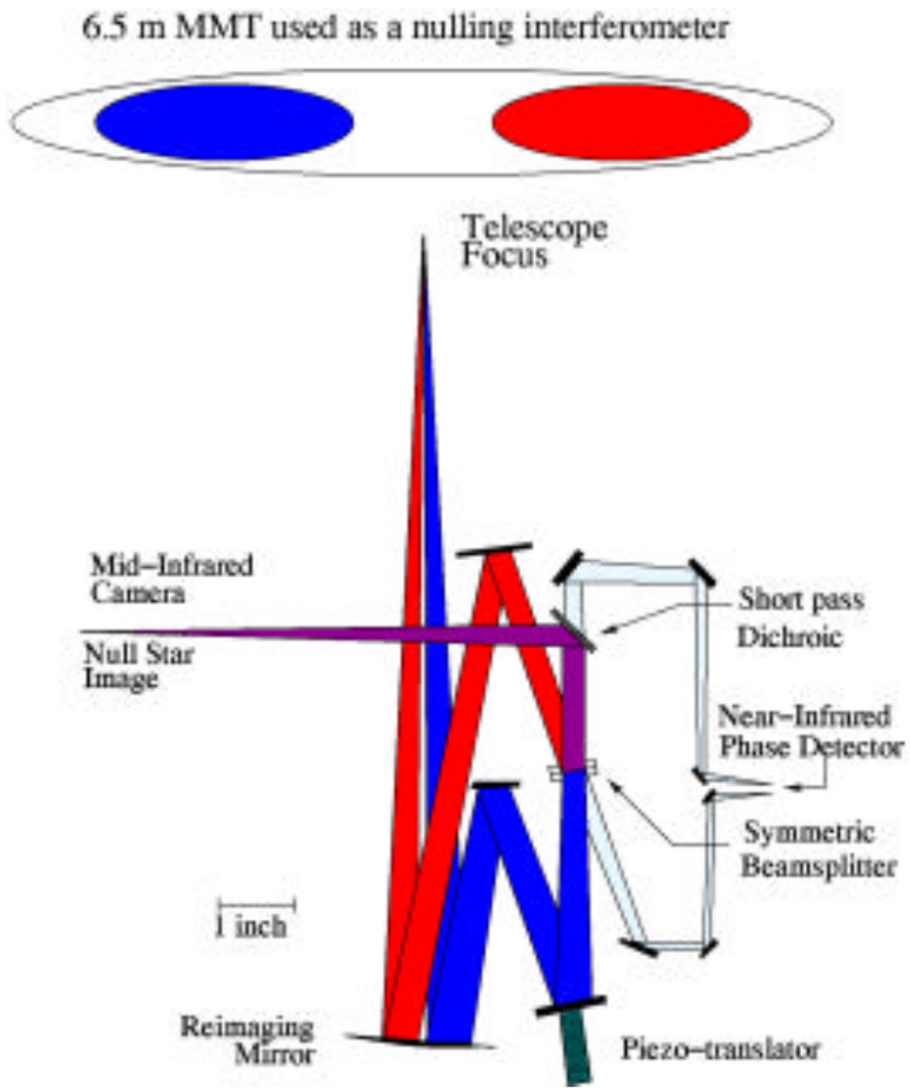
LBTI Reconnaissance

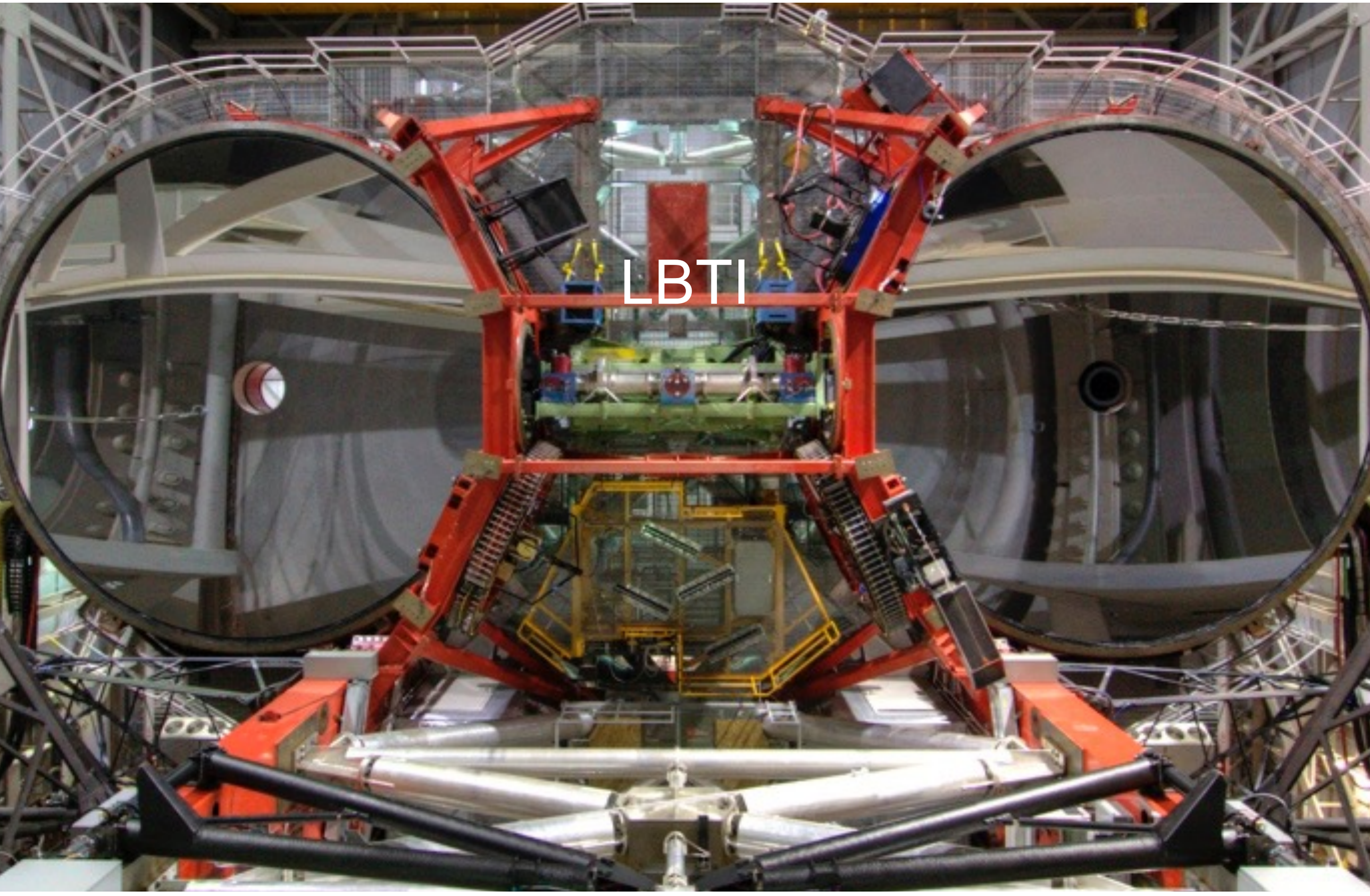
Hunt for Observable Signature of Terrestrial Planets
(HOSTS)

LBTI Exozodi Exoplanet Common Hunt
(LEECH)

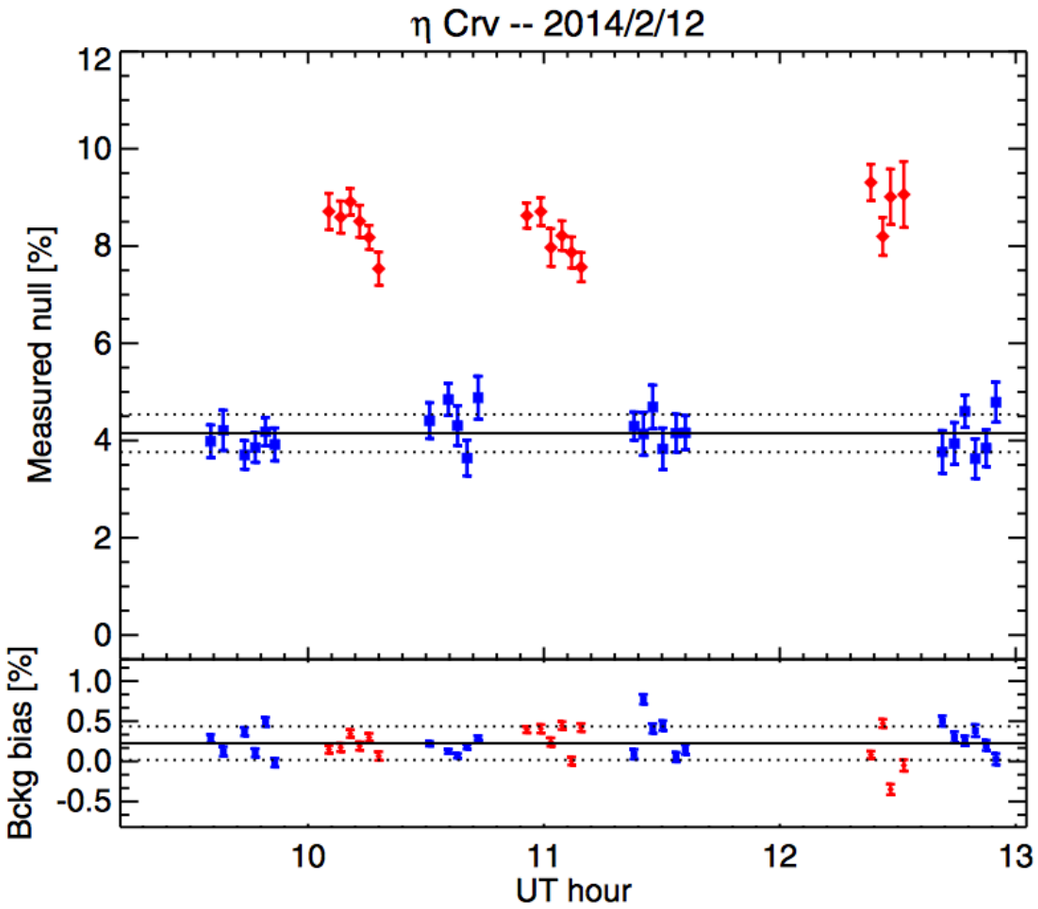


My Michelson Proposal



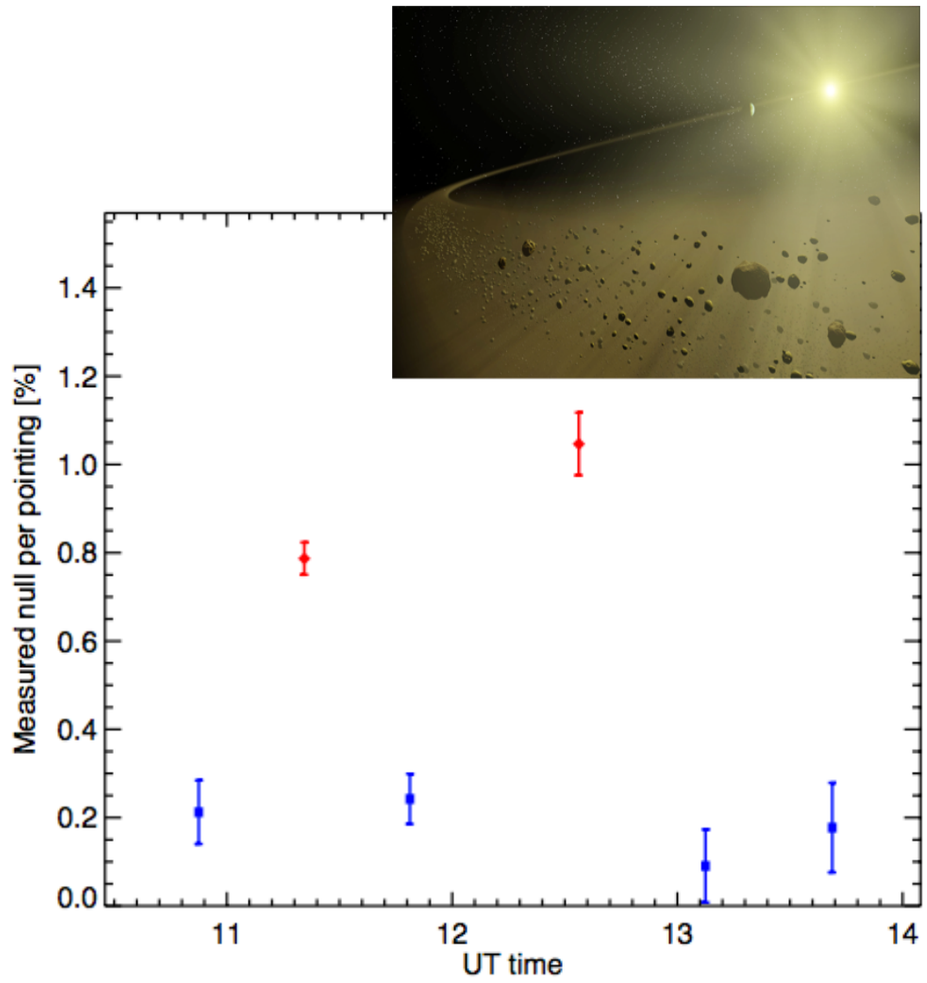

LBTI

LBTI's first disk detections



Commissioning tests on the star eta Crv detected a bright disk (Defrere et al. 2015).

Modeling indicates dust is at < 1 AU.

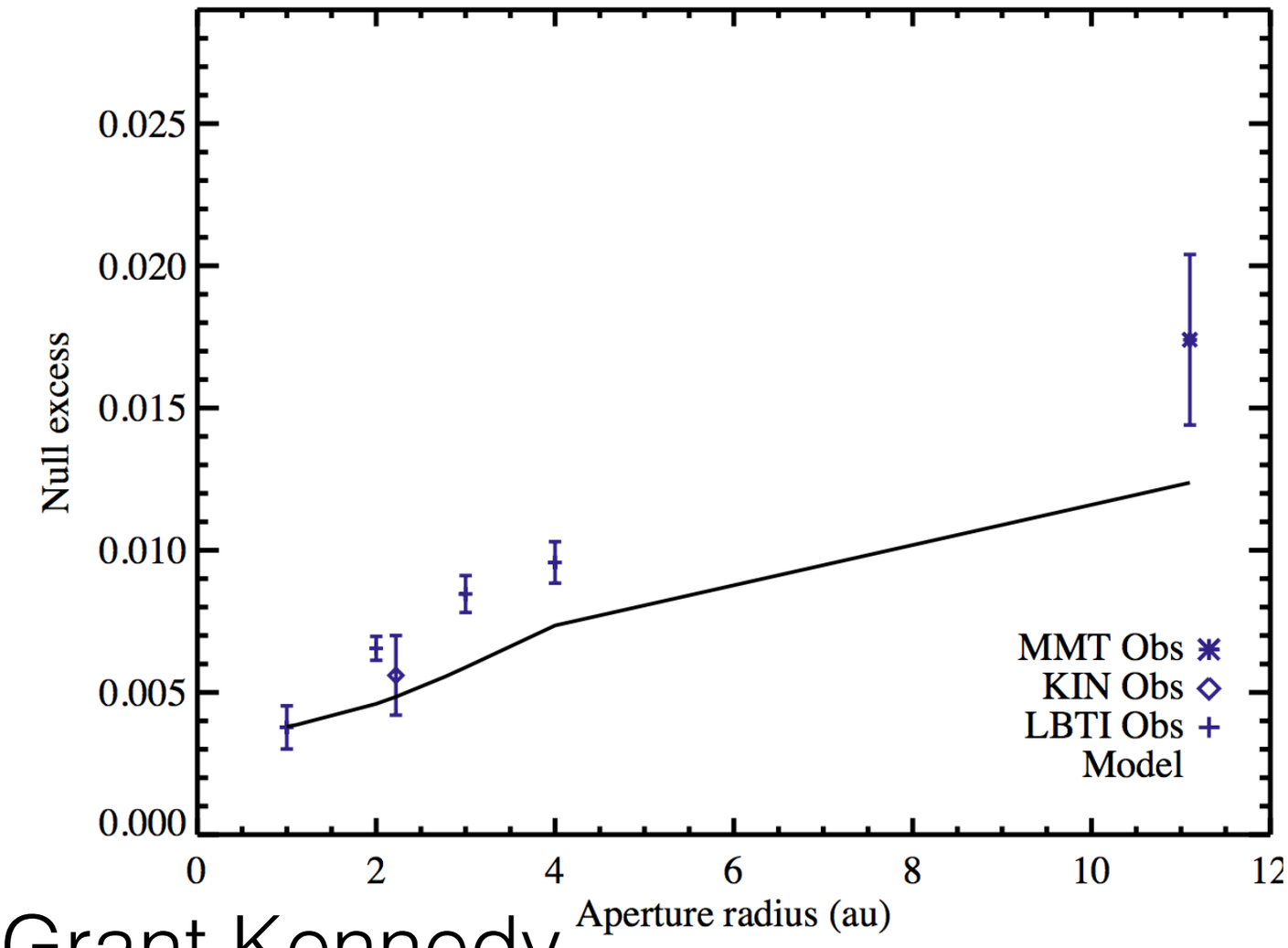


Commissioning tests on the star β Leo detected a disk at the level of 6000±500 ppm.

This corresponds to a disk that is **90 ± 8 zodi.**

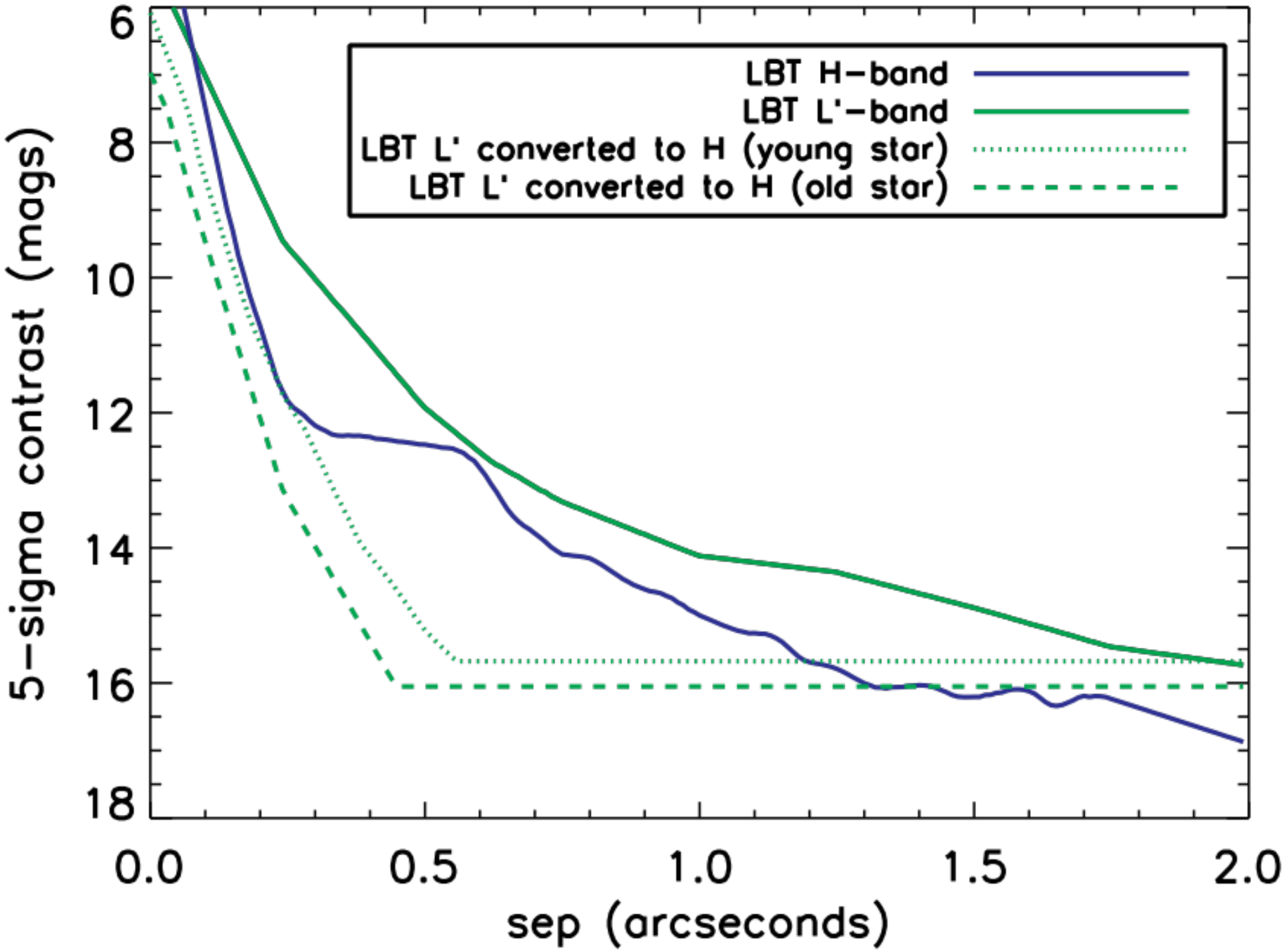
Cold Disk vs. Warm Disk

- Cold Disk resolved by Herschel.
- P-R drag from this reservoir appears to be consistent with the warm emission

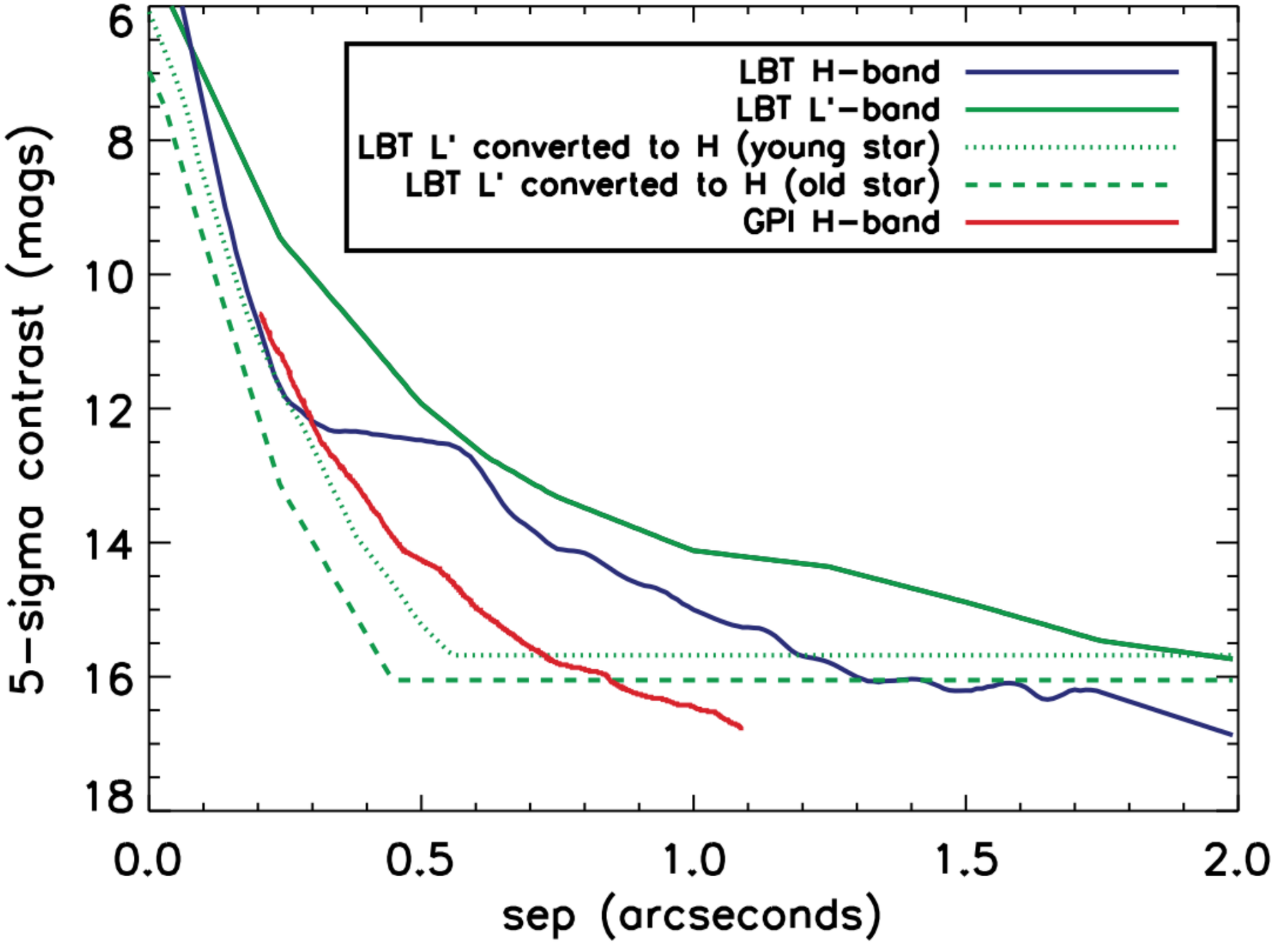


Model from Grant Kennedy

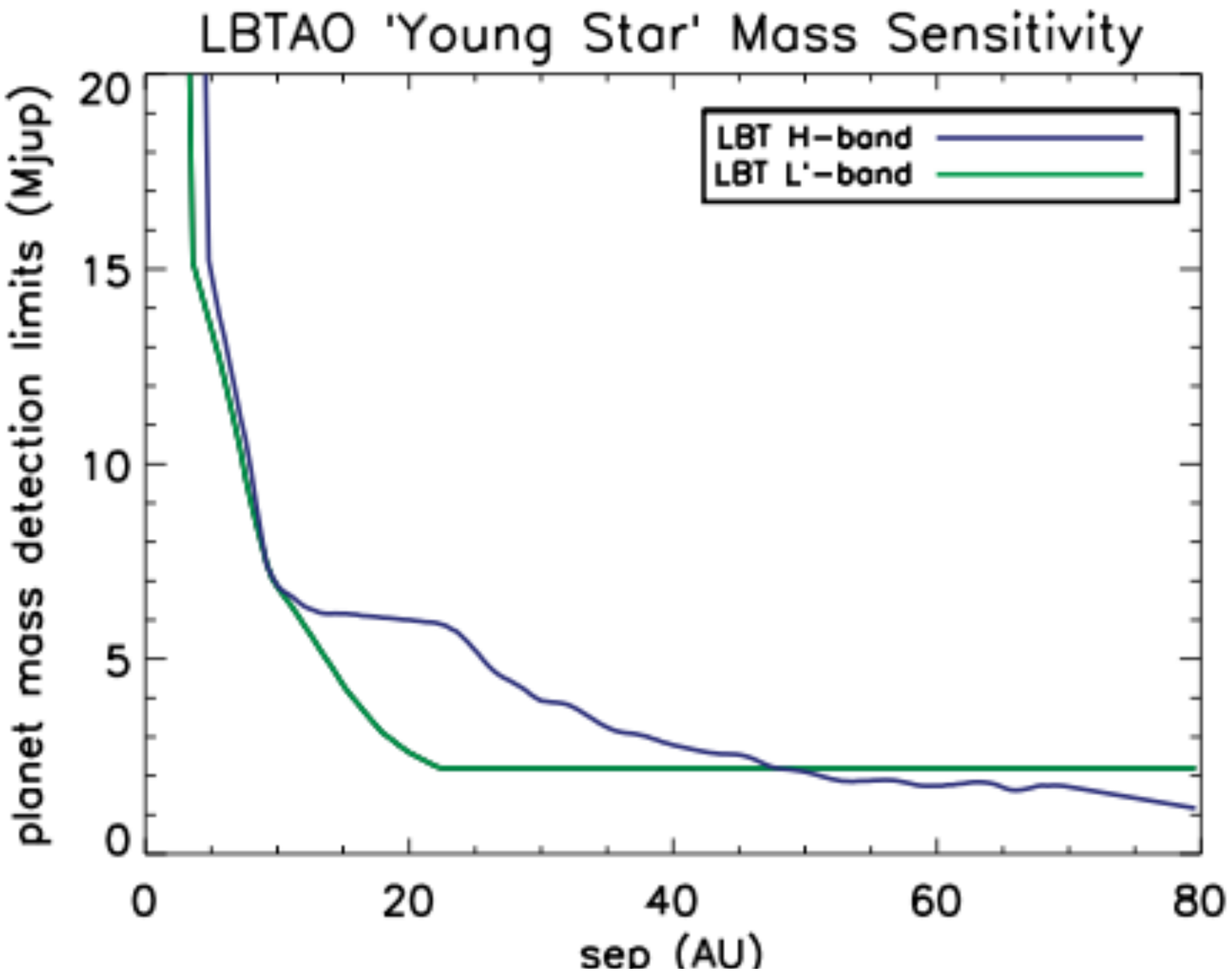
LEECH Sensitivity



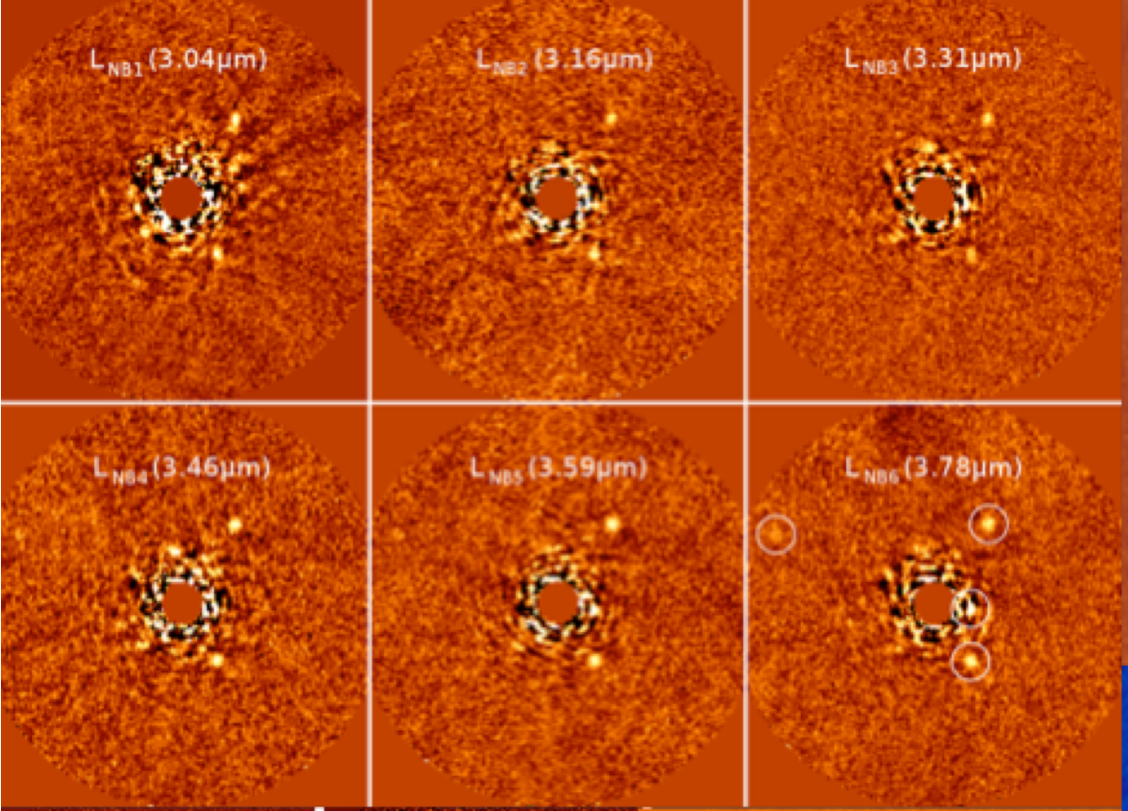
LEECH Sensitivity

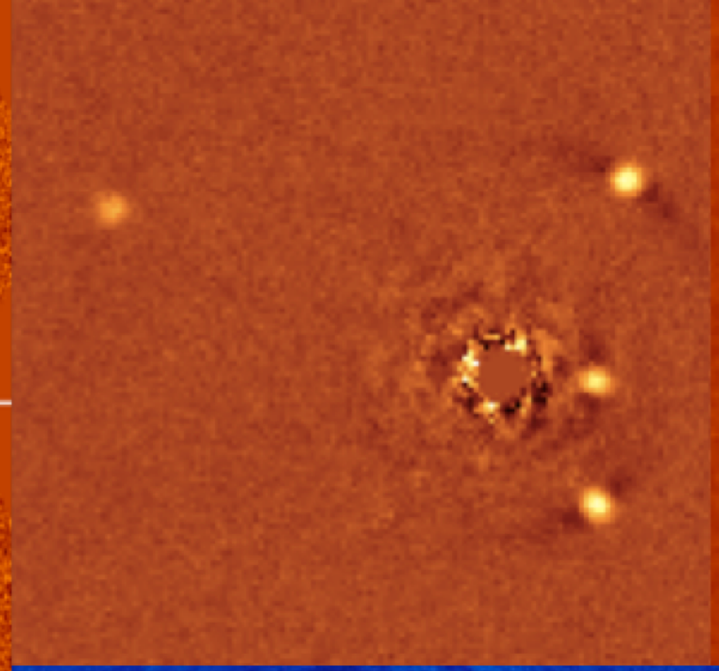


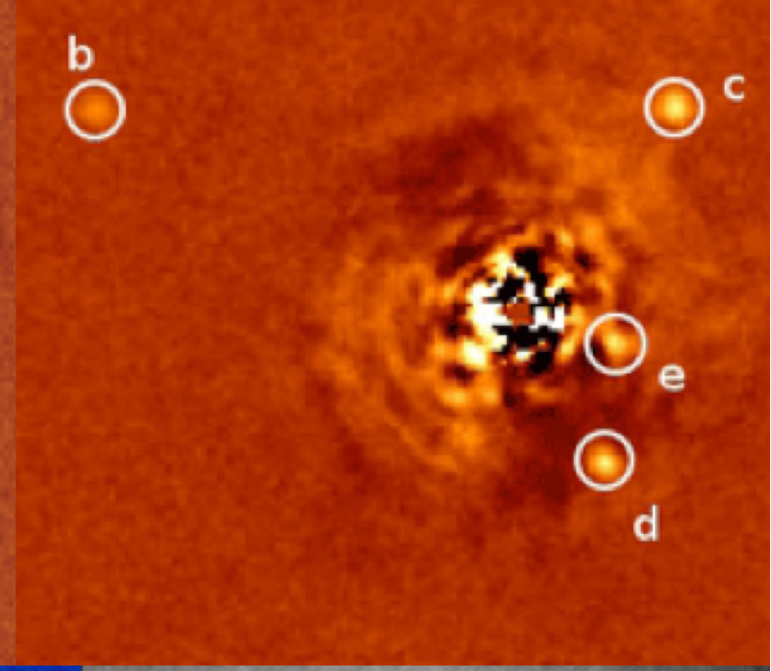
Sensitivity for beta Leo

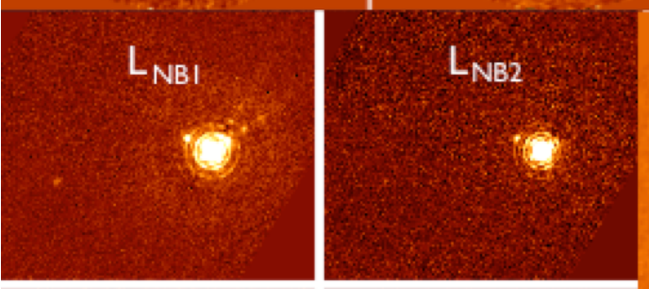


Skemer et al. 2014

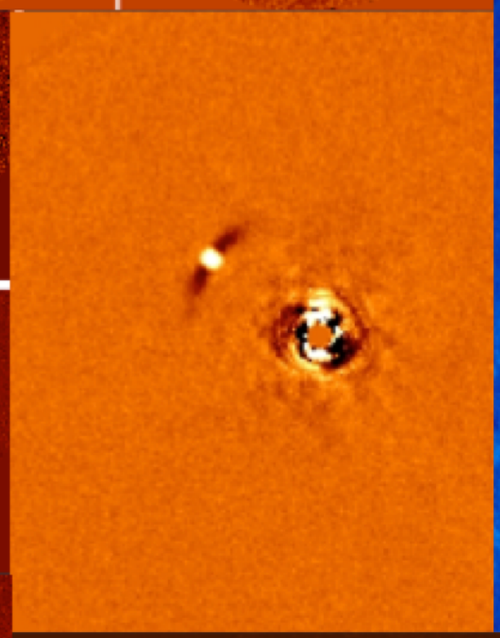

L_{NB1} (3.04μm)
L_{NB2} (3.16μm)
L_{NB3} (3.31μm)
L_{NB4} (3.46μm)
L_{NB5} (3.59μm)
L_{NB6} (3.78μm)

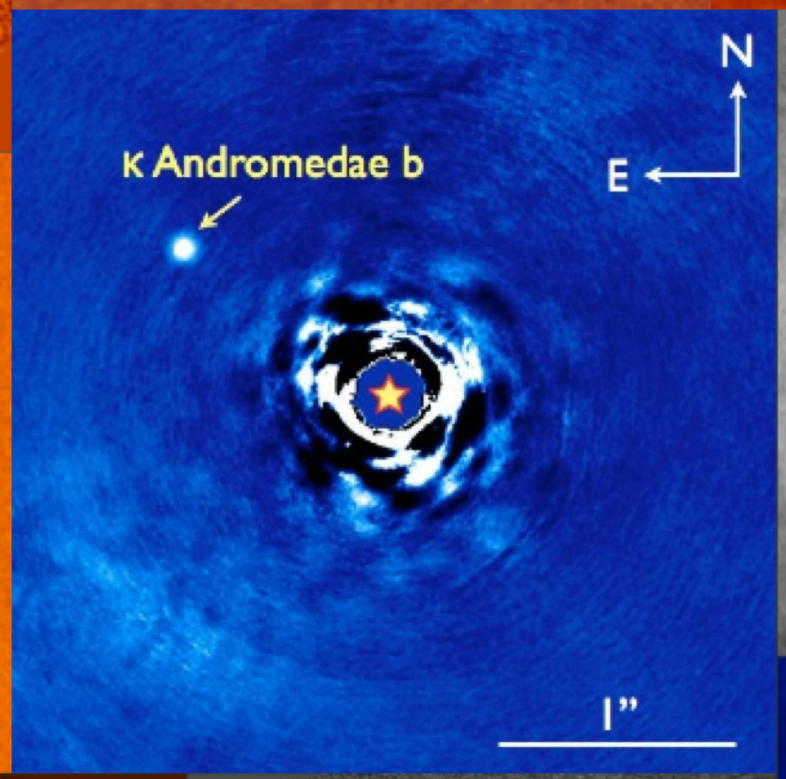



b
c
e
d


L_{NB1}

L_{NB2}

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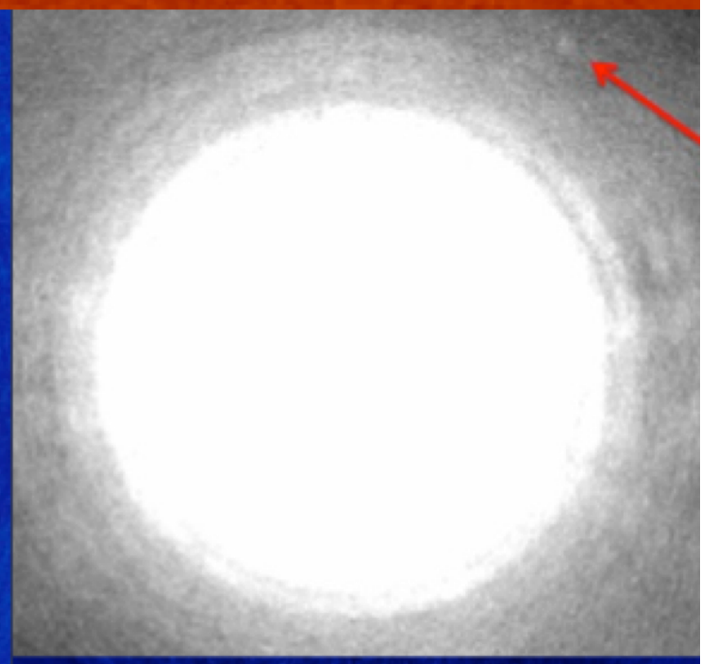
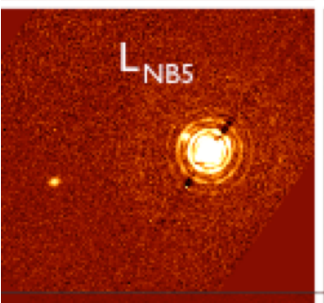
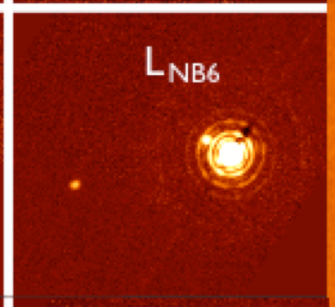
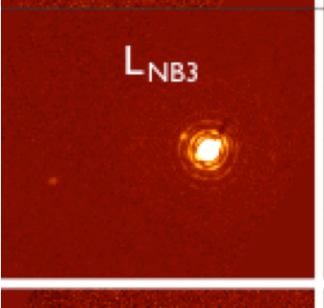
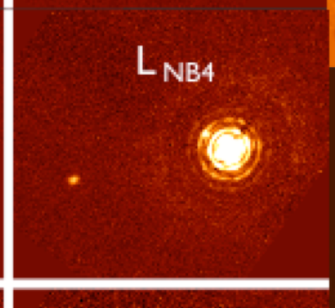
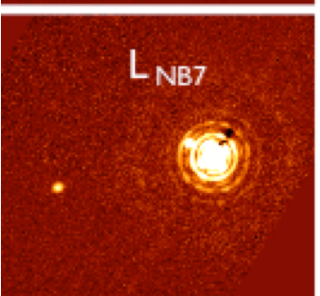


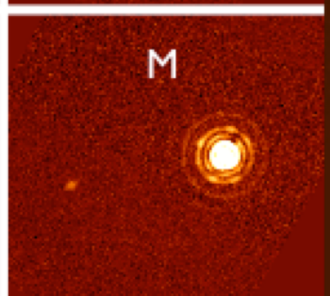

L_{NB5}

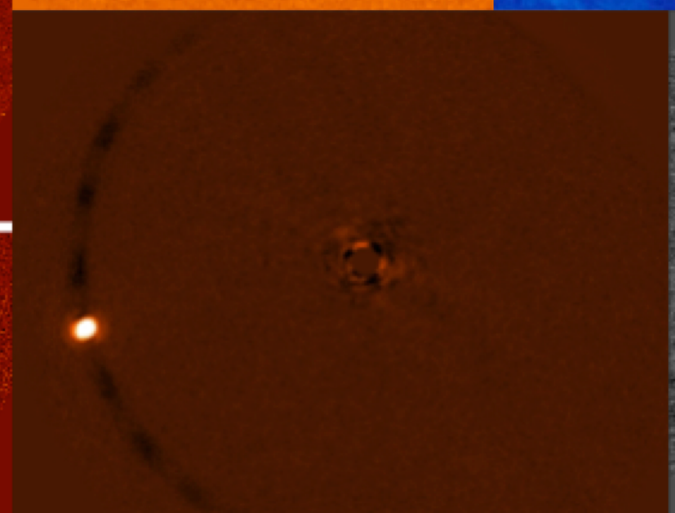

L_{NB6}

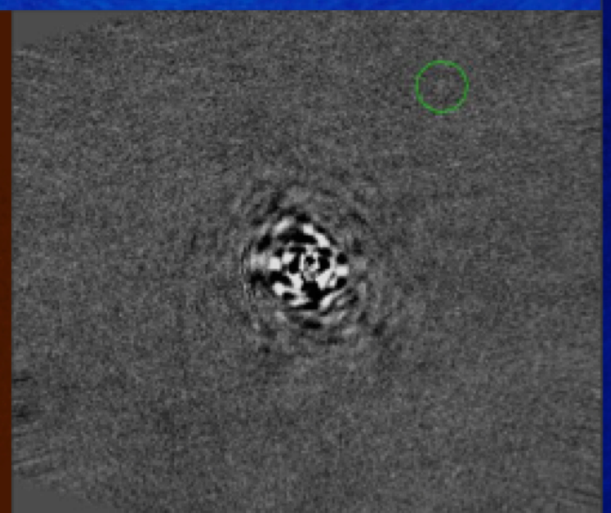

L_{NB3}

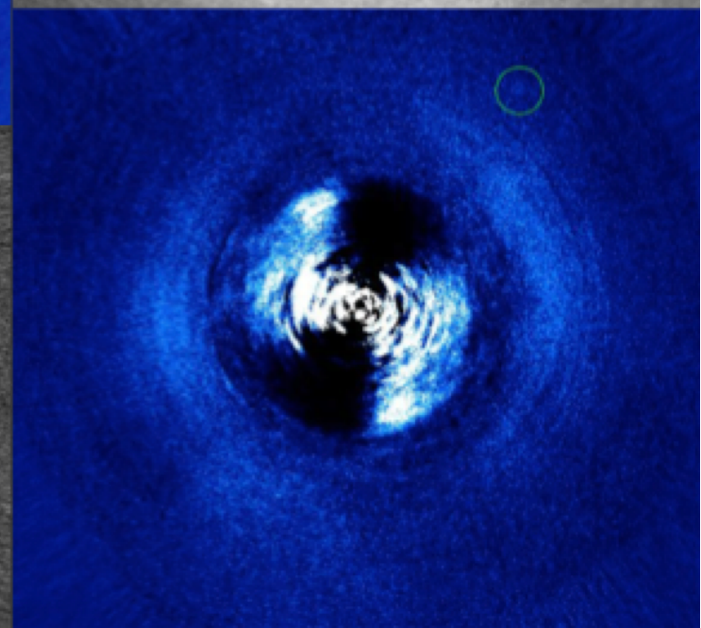

L_{NB4}


L_{NB7}

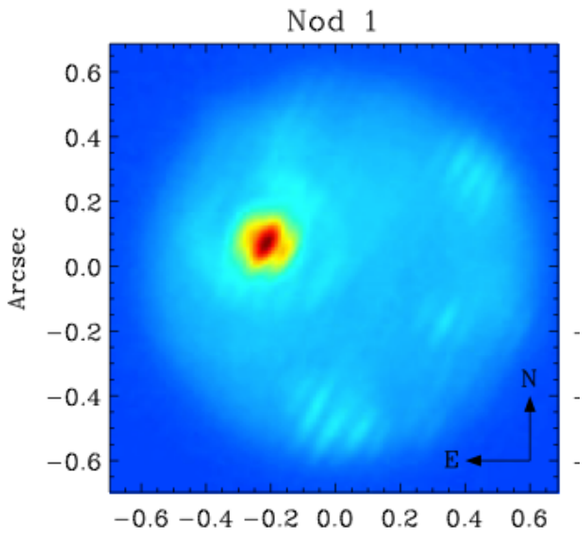

M

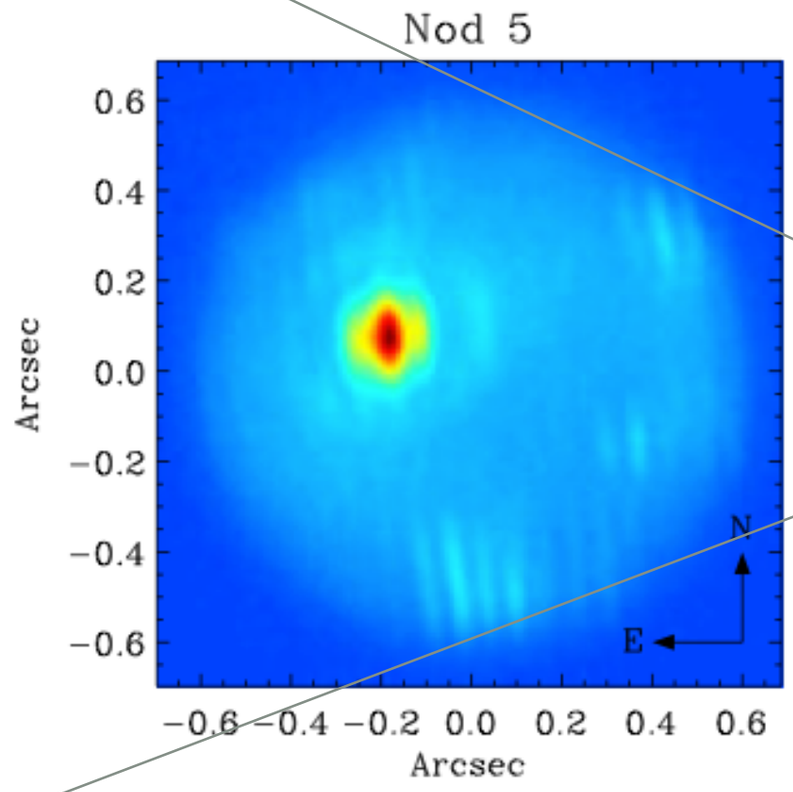


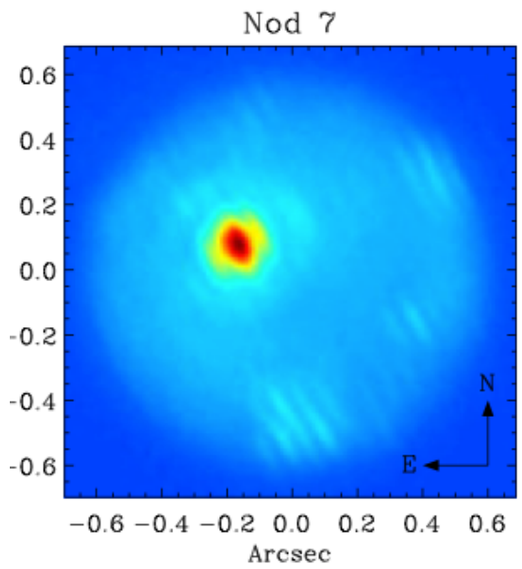




Imaging at 23 m resolution

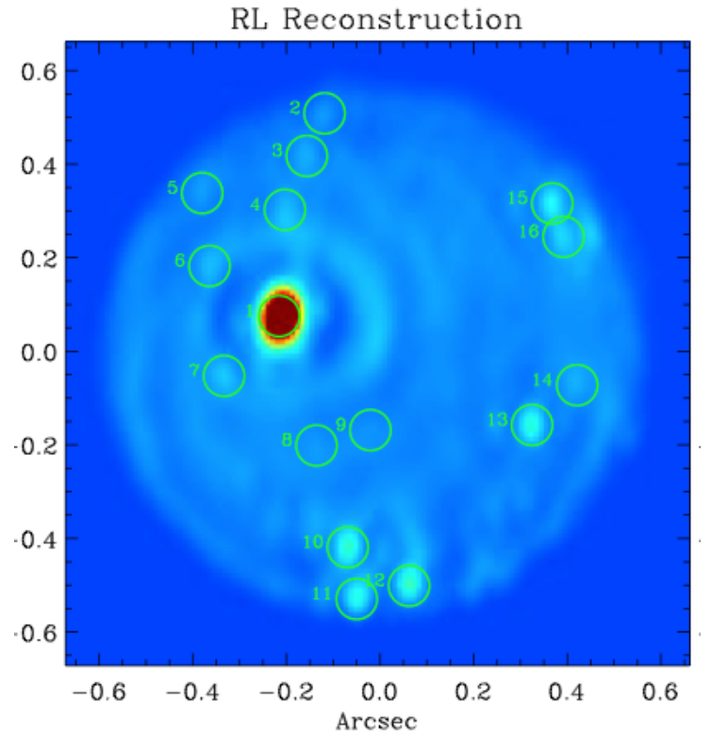






Jupiter's moon Io, at 4.7 μm wavelength

14 volcanoes resolved



43 mas resolution on a complex structure

Conrad et al. 2015

Summary

- LBTI is observing nearby stars for giant planets with the LEECH Survey.
  - Typical sensitivity is 1-5 MJ at 5-20 AU.
- The LBTI HOSTS survey for dust is beginning this fall.
  - Typical sensitivity is 11 zodies in the habitable zone.
- Results from these surveys will provide helpful context and input for future exo-Earth imaging missions.