ELTs and the Future of Direct Imaging, Toward that Pale Blue Dot Picture

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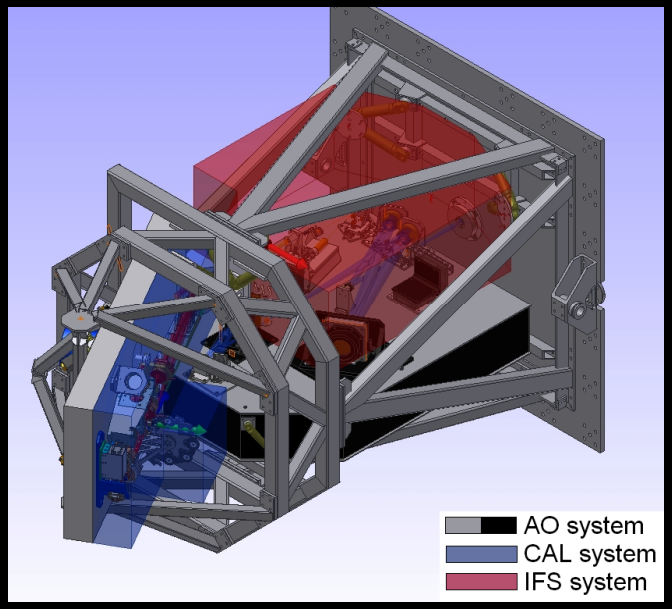
NRC - Herzberg

TMT, Washington June 2015

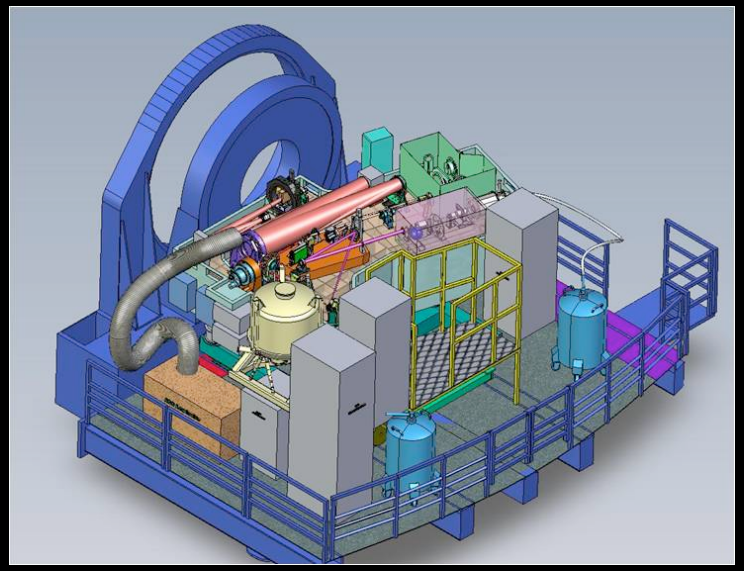
A new ERA is beginning

Ground-based ExAO: 2015-2025

GPI



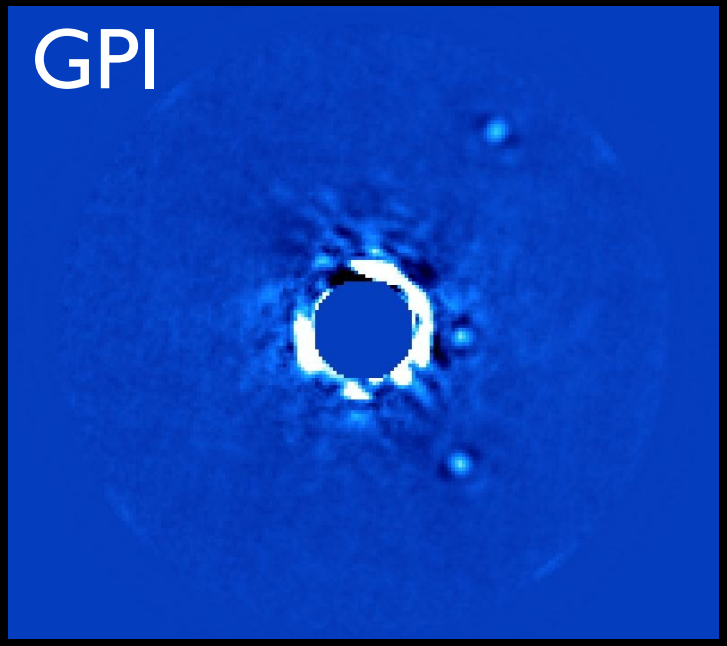
SPHERE

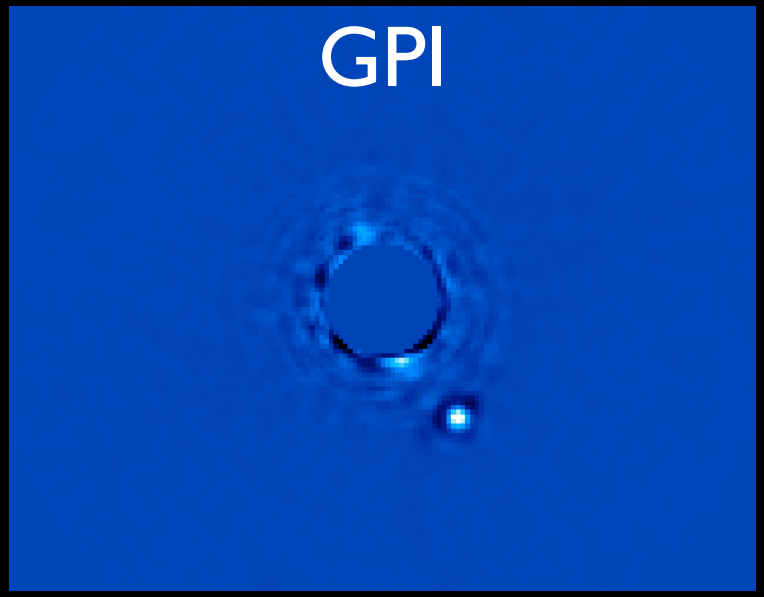


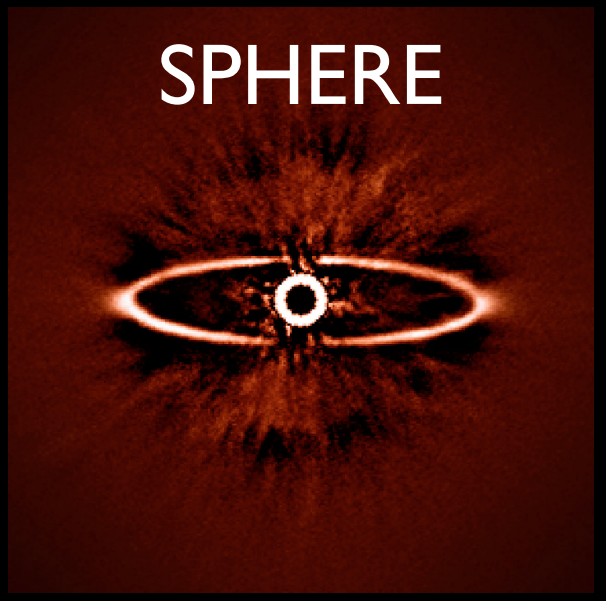
SCExAO LBT

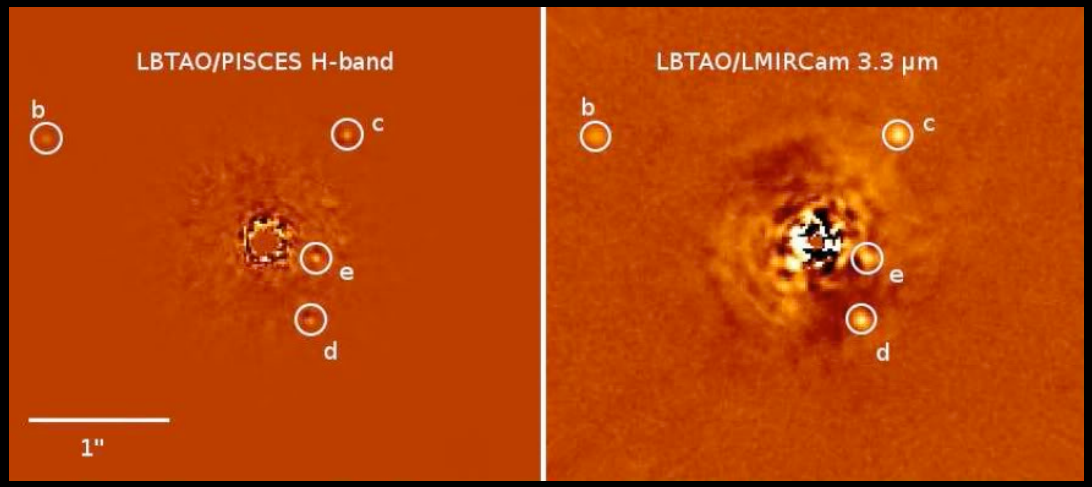
~50x better than the previous generation!

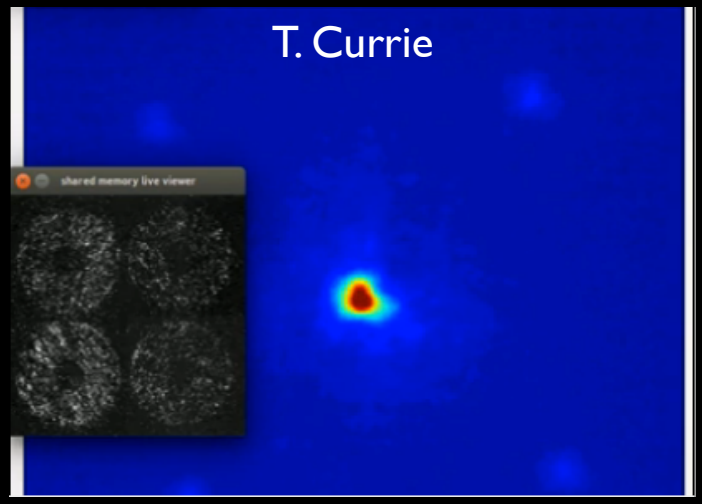
Spectroimaging, SSDI & ADI







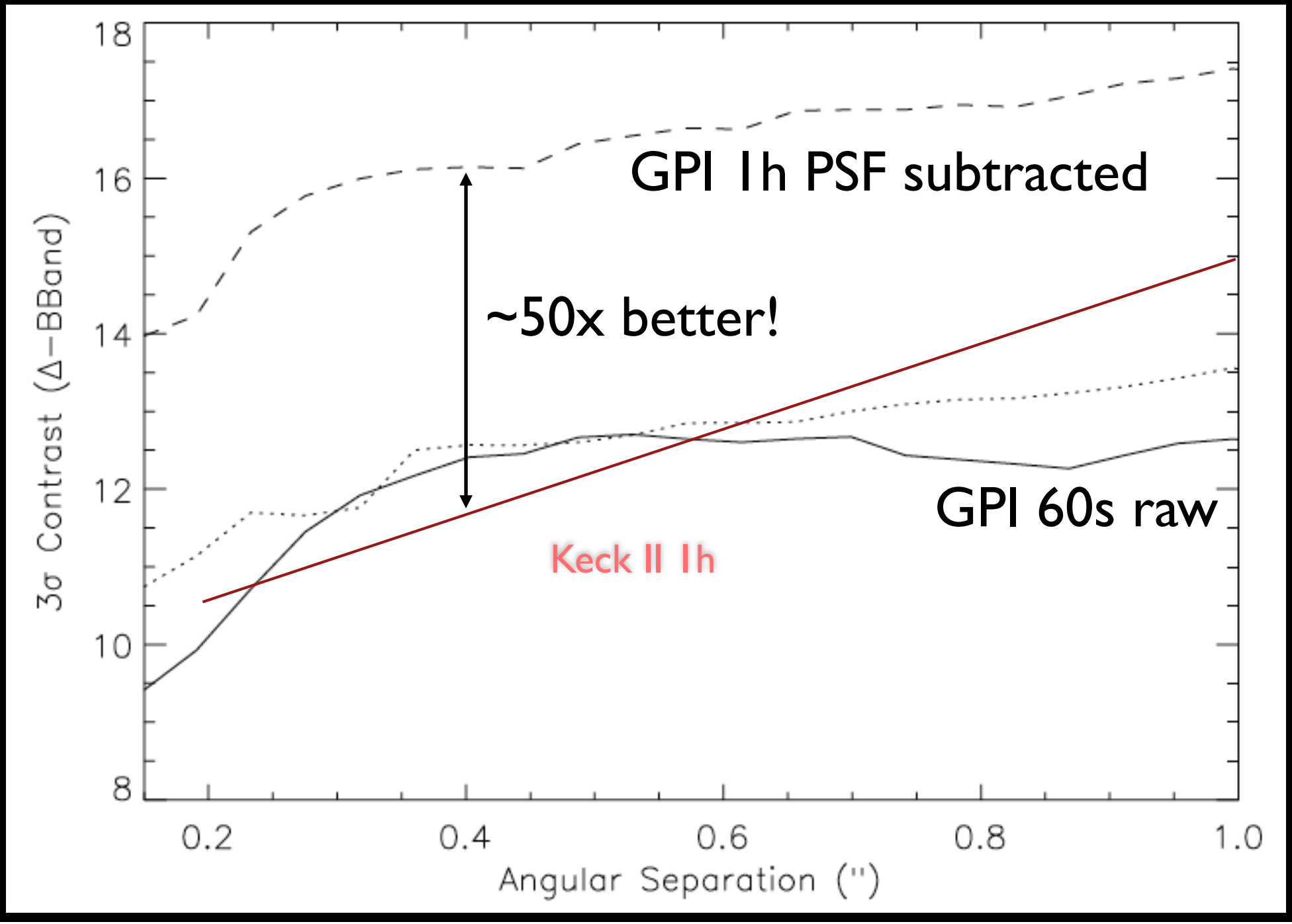




SCExAO 0.7 microns

The battle of the giants,!

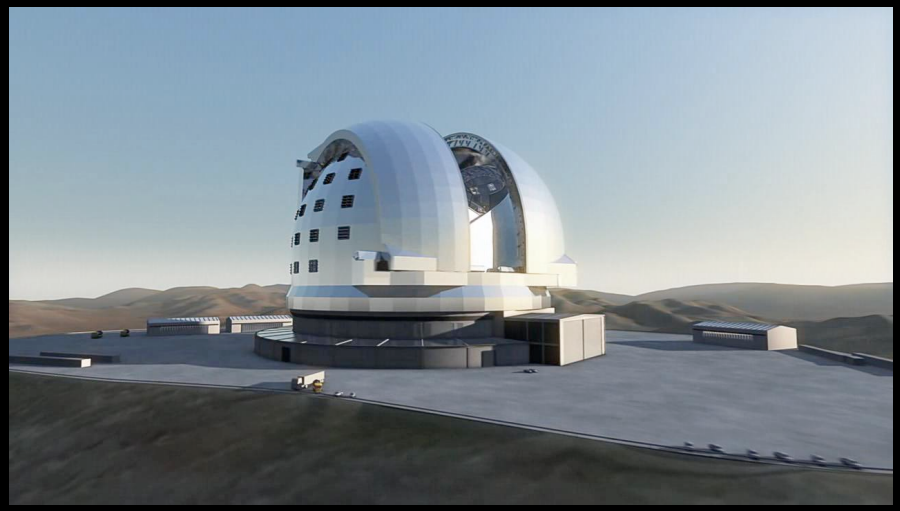
GPI H-band contrast TLOCI methane 1h

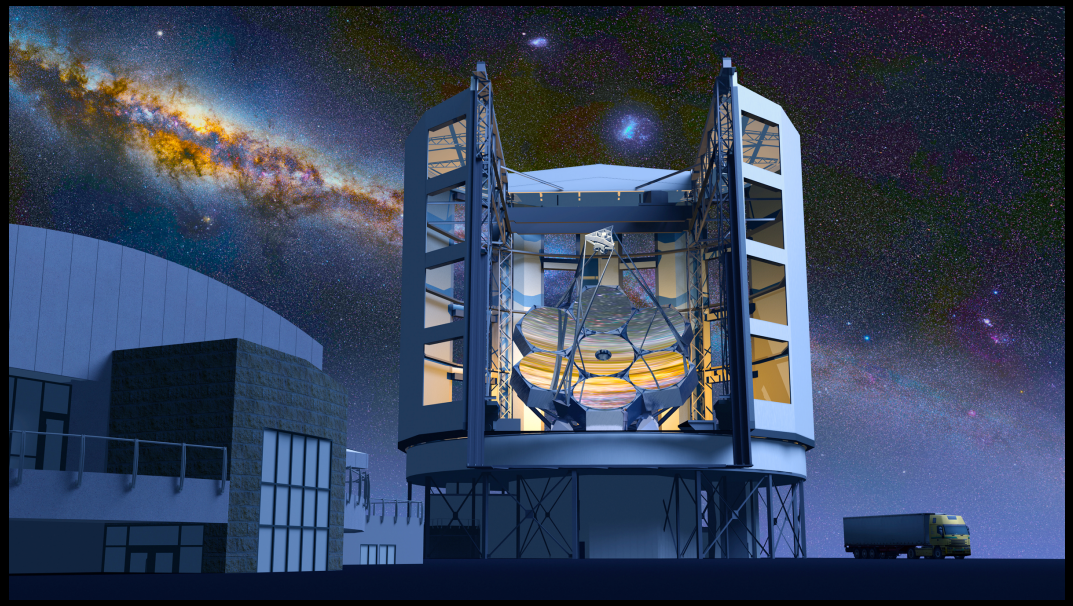


Survey goals

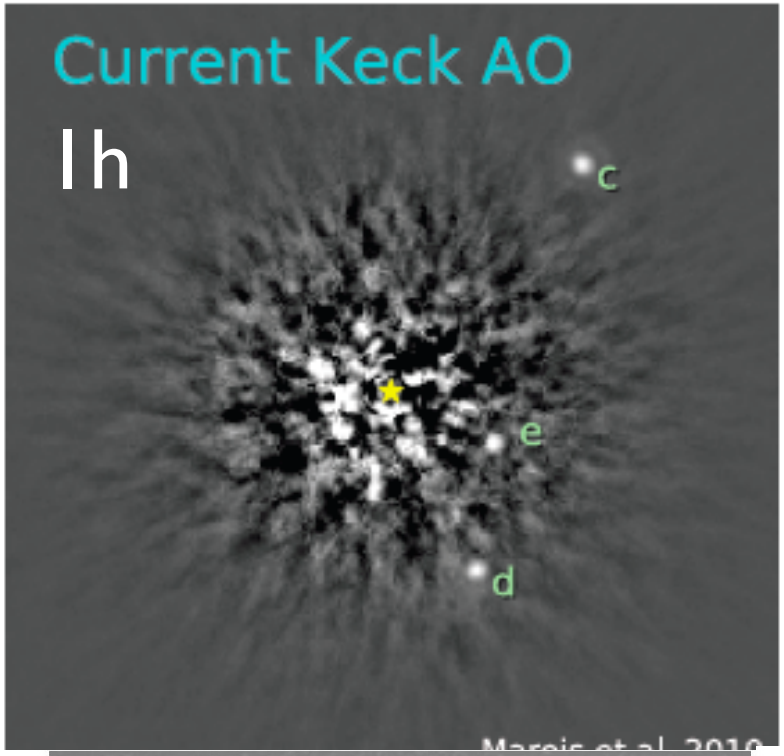
- Improving statistics for gas giant planets >10 AU down to ~2 MJup
- ~400K planets (Y dwarfs)
- Orbit/multiplanet system dynamic

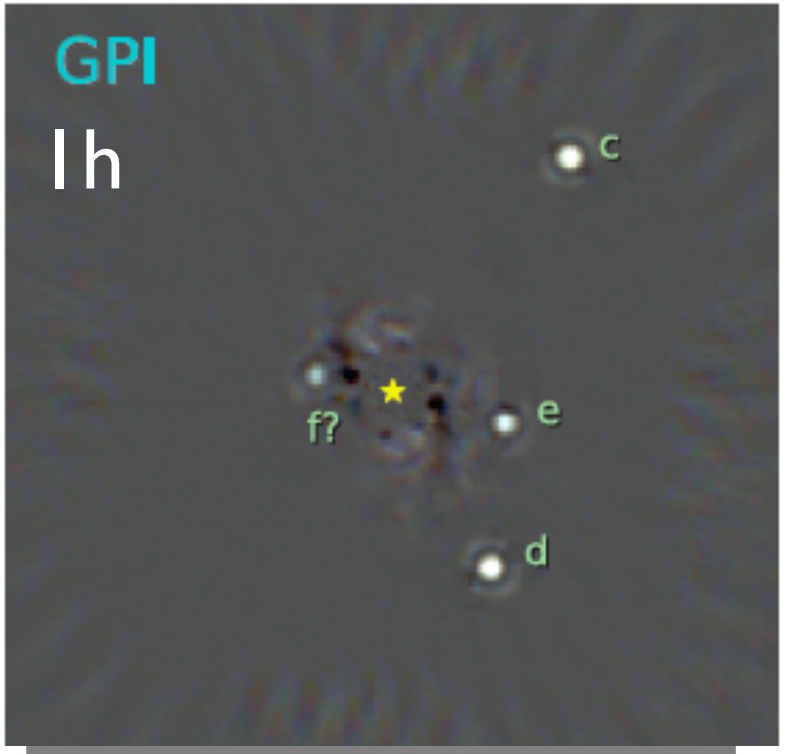
The ELT Era 2023-

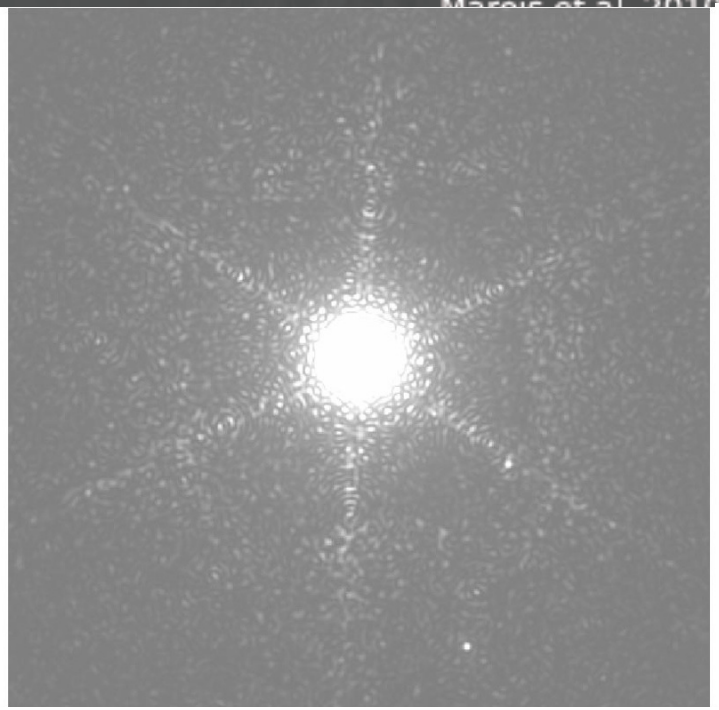


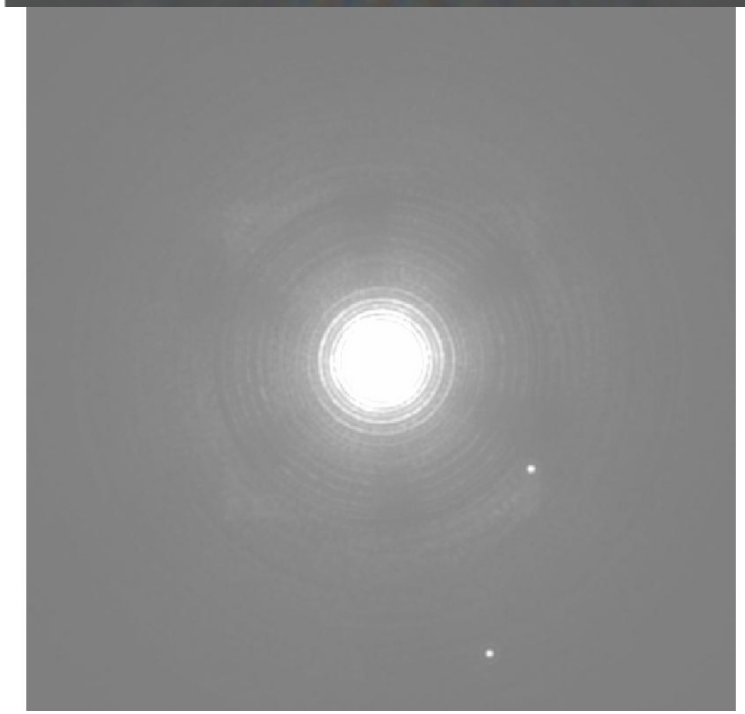


- 3-4x the diameter
- 9-16x the flux
- Potentially could take images of an Earth-like planet

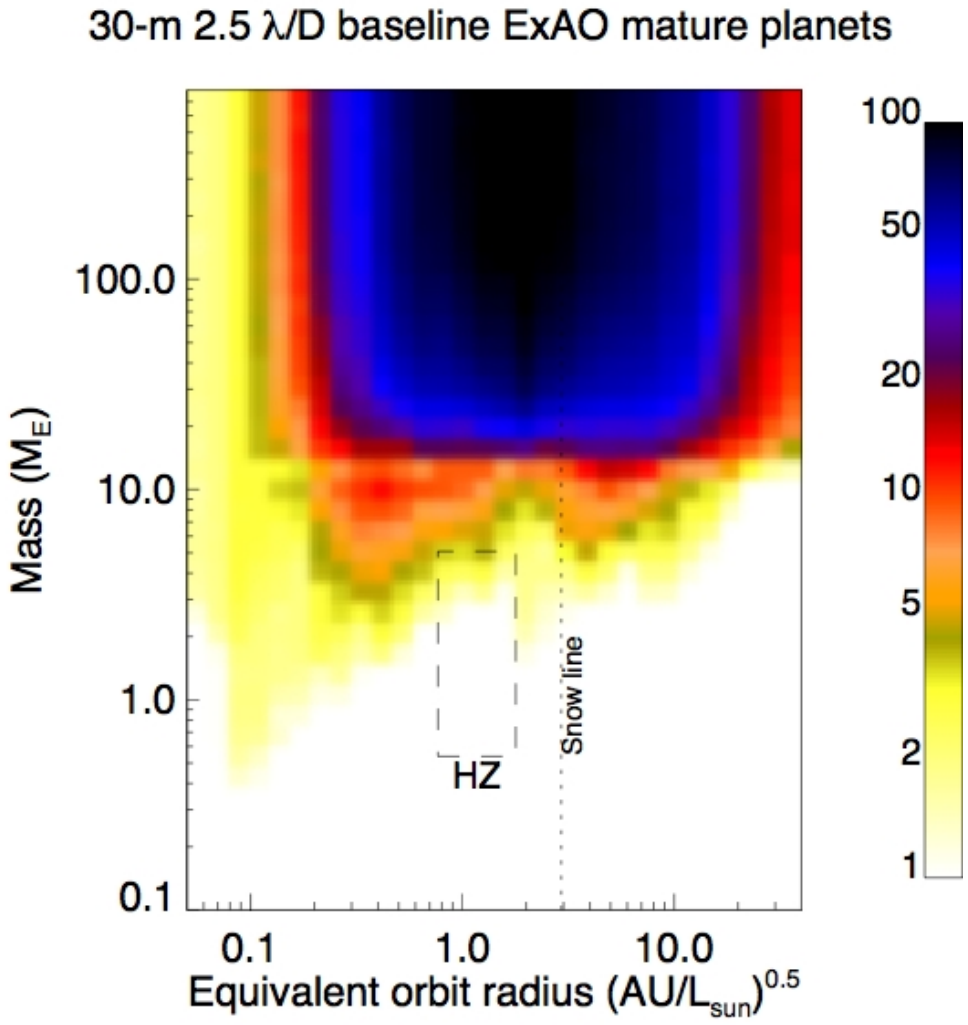

Current Keck AO
Ih
c
e
d


GPI
Ih
c
f?
e
d

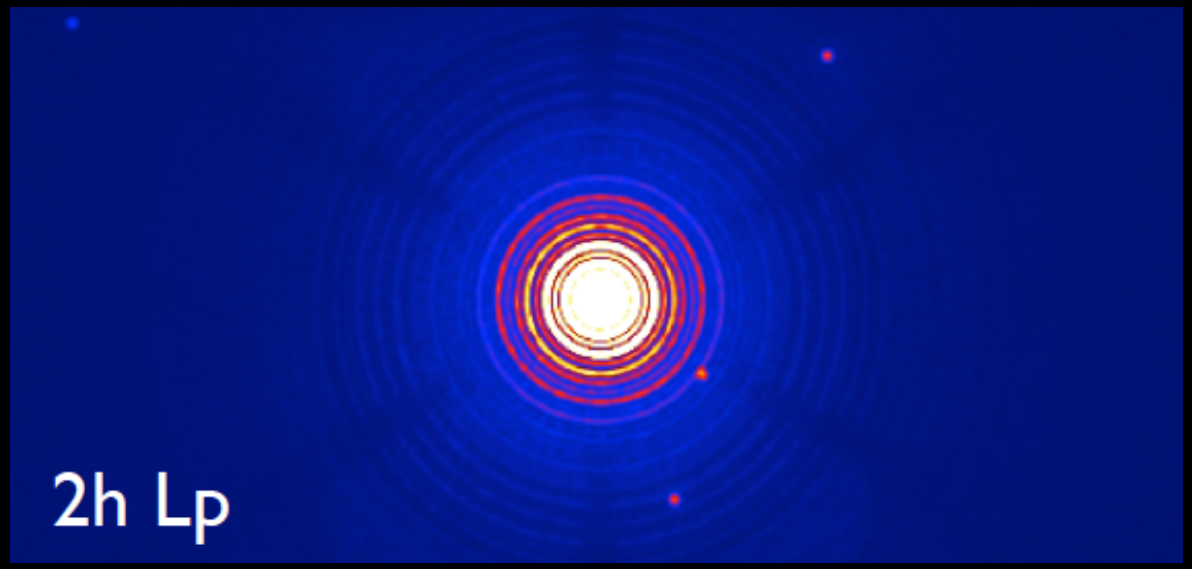


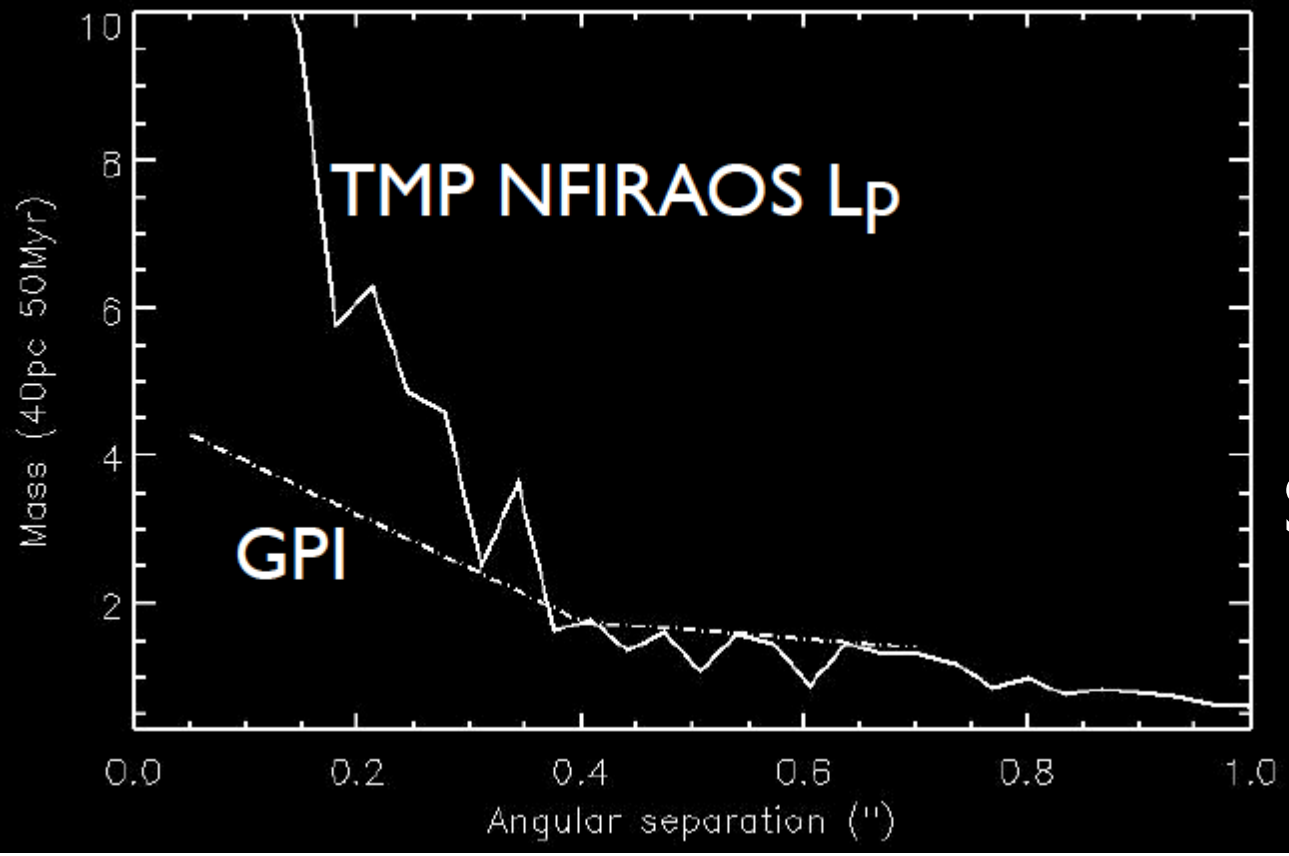


Ground-Based Direct Imaging



The mid IR to thermal IR potential

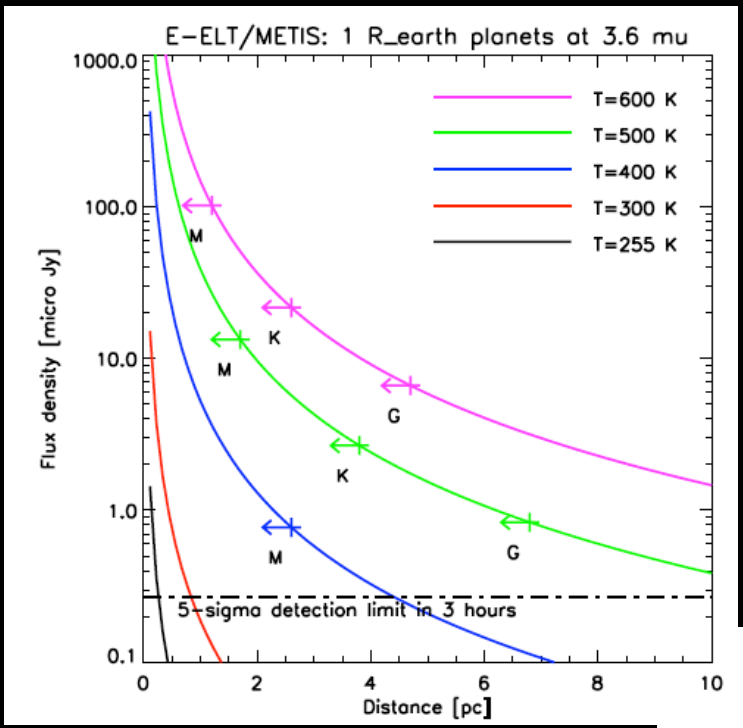


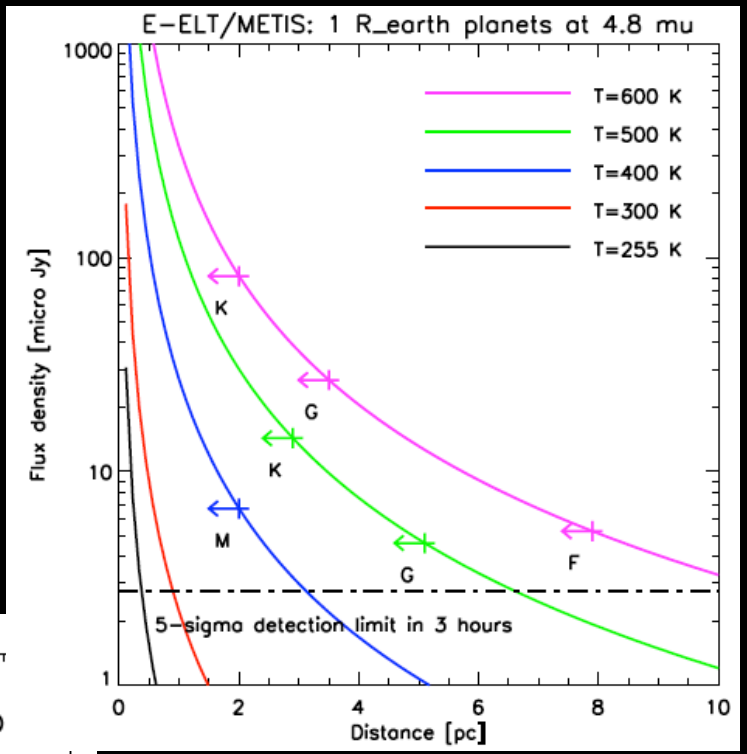


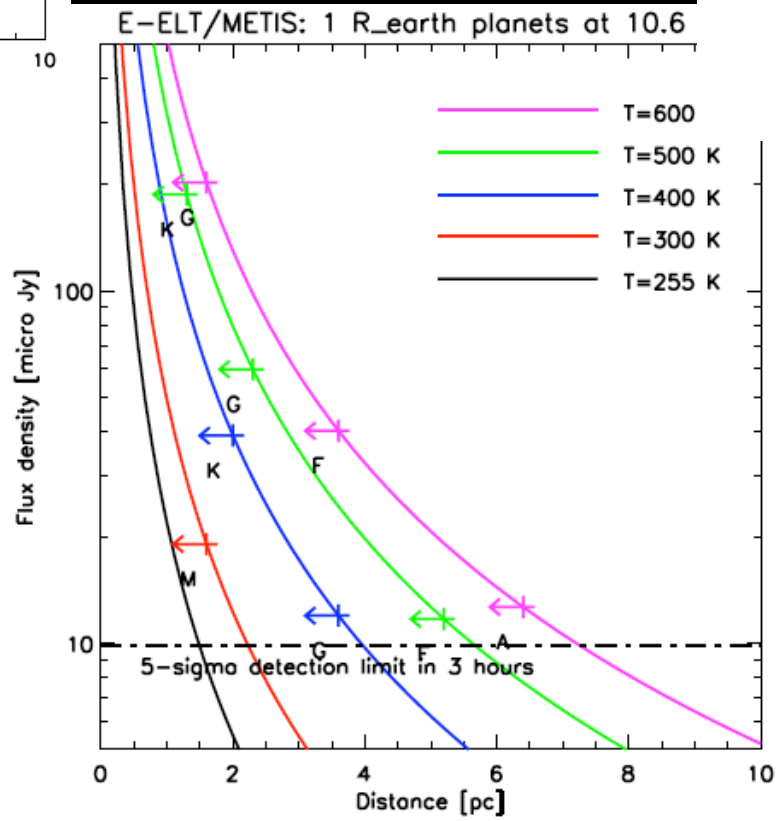
Luminosity
Clouds
Non-eq chemistry

Saturn-mass planets

5-10 microns

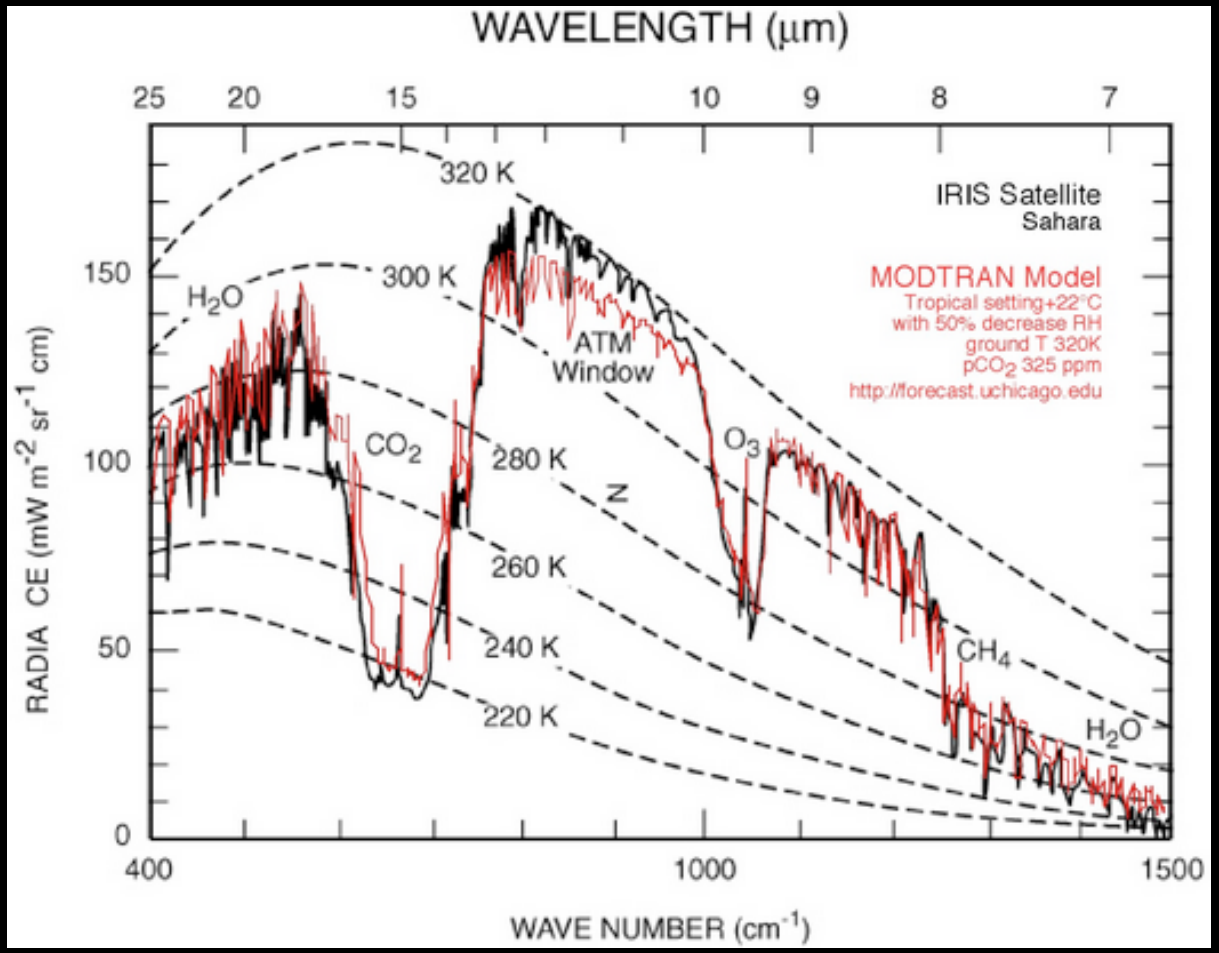






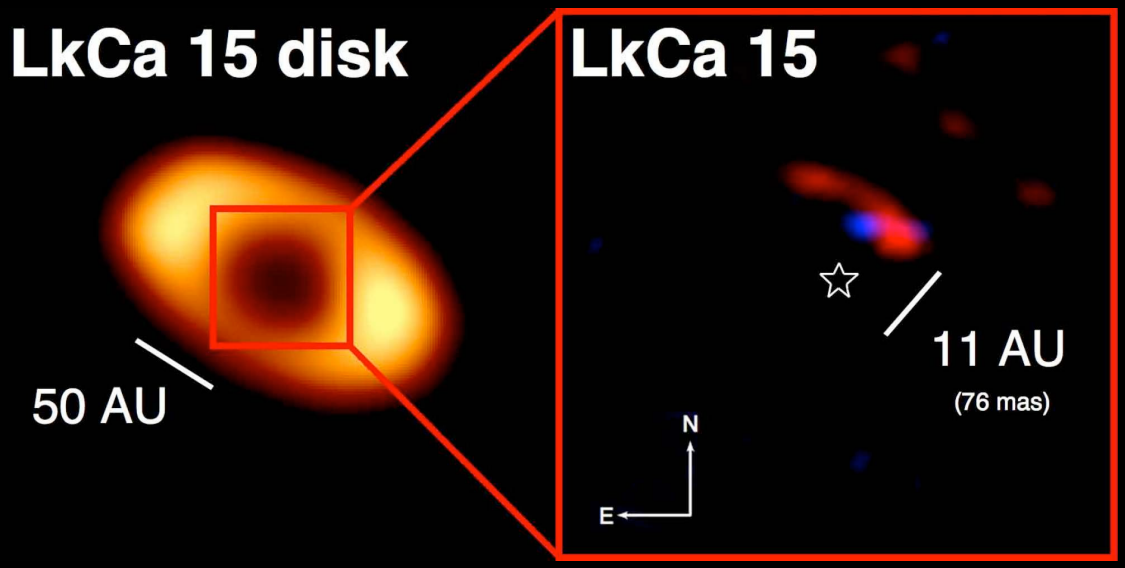
Quantz et al. 2014

10 microns cryogenic/defor. 2nd ExAO system
Nearest stars



Best target would be Alpha Cent A/B, but not from MK.
10-20 stars feasible from MK

SFR forming exoplanets

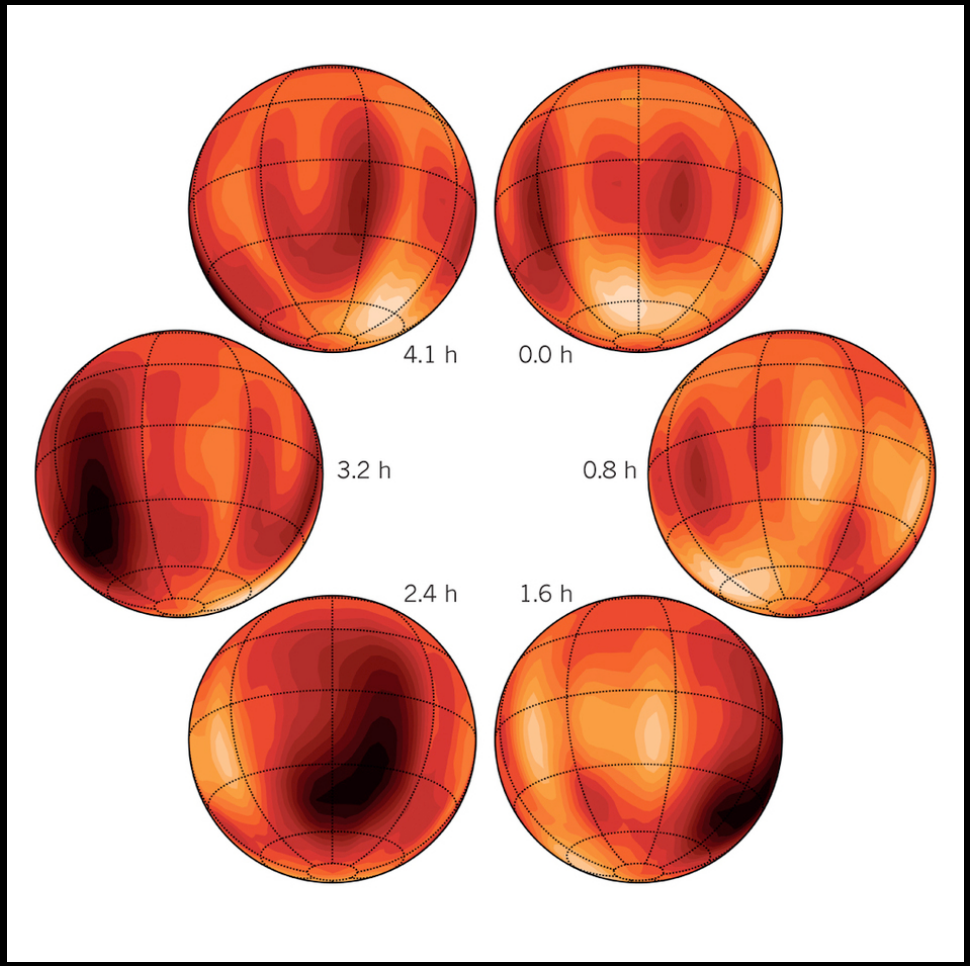


Kraus & Ireland 2011

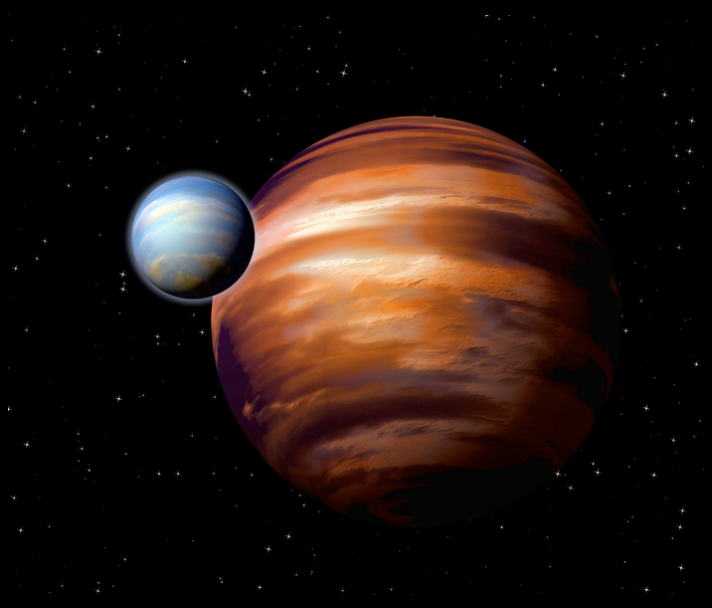
Doppler Imaging of exoplanets

Hires R-100,000 spectroscopy

Features on Exoplanets



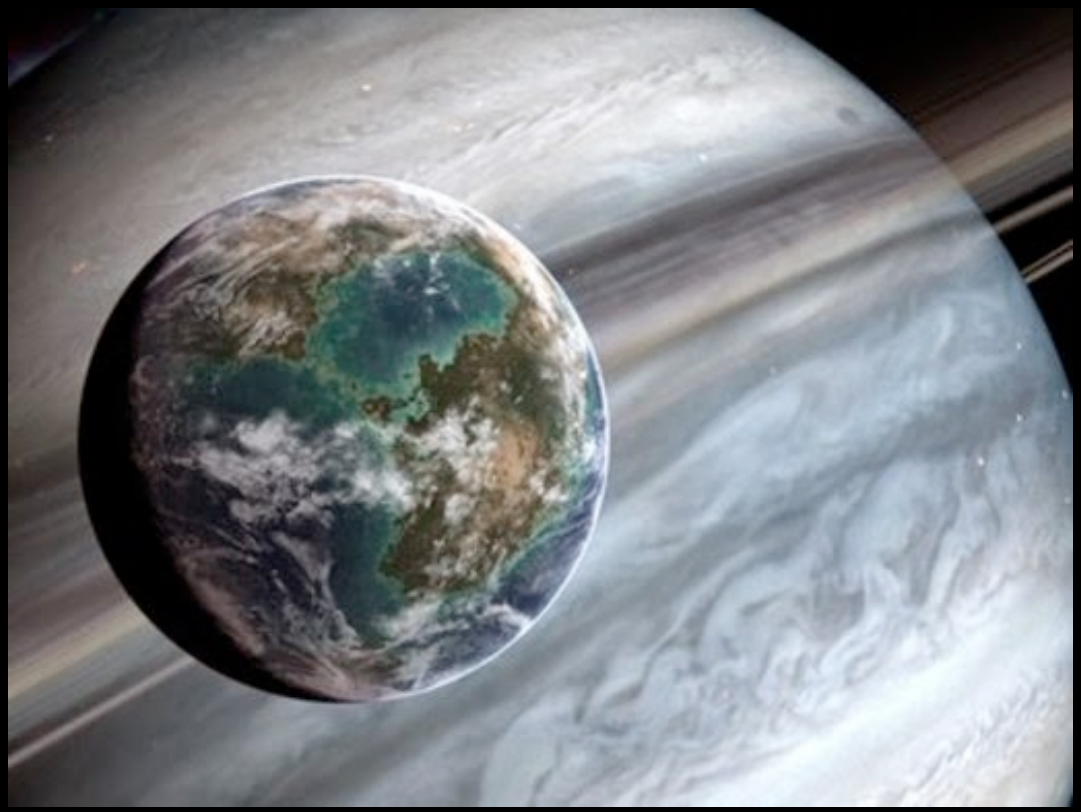
ExoMoons PRV



- NIR High-contrast imaging instrument + PRV NIR spectrograph?
- An Earth-mass planet around a few Jupiter mass planet has an RV of ~10 m/s

Exomoon transits?

- NIR High-contrast imaging instrument, several days campaign at high SNR photometry.



ELTs Goals (direct imaging)

- ~3-4x closer in gas giant planets (down to a few AUs)
- Planets around BDs (lower mass stars)
- ~Saturn masses L/M-band imaging, Earth size at 10 microns. Surveys?
- More multiplanet systems
- SFR (protoplanets)
- Exomoons (PVR & transits)
- Doppler Imaging