Direct Imaging and Spectroscopy of Extrasolar Planets with SCExAO

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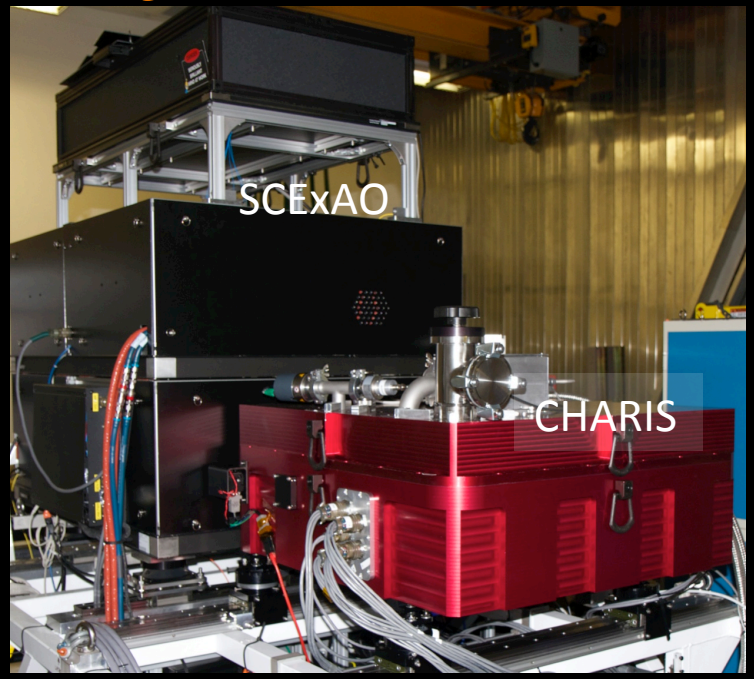
Olivier Guyon, Tyler Groff, Jeremy Kasdin, Nemanja Jovanovic, Julien Lozi,
Tim Brandt, Tomoyuki Kudo, Motohide Tamura, Taichi Uyama,
+ many others

SCExAO Project

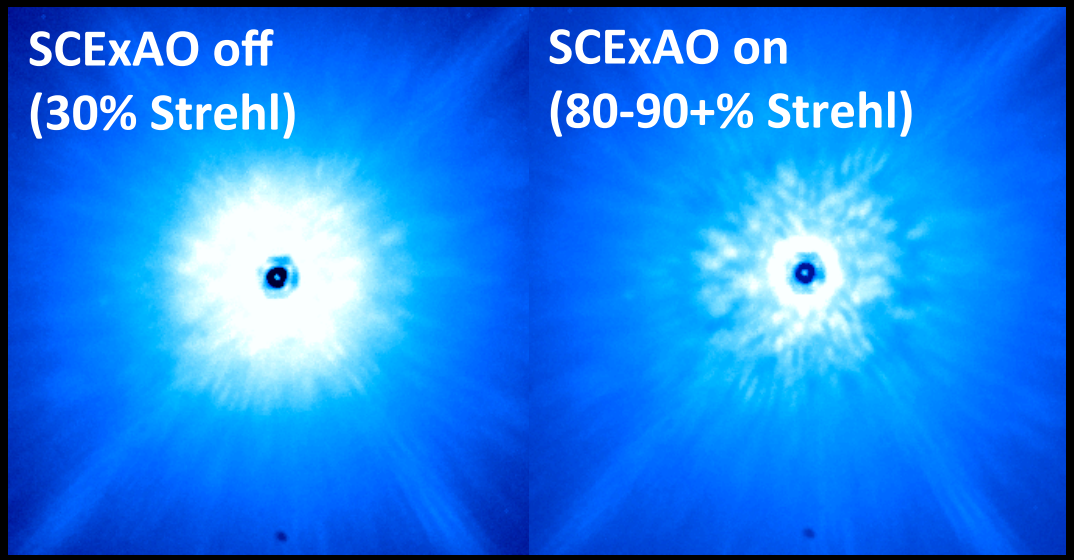
What it is:

- Extreme AO System for Subaru (PI Olivier Guyon)
- Pyramid Wavefront sensor, 2000 actuators
- Rapidly Corrects for Atmospheric Blurring: 1080 modes, 3.5+ kHz
- S.R. > 90% at H band



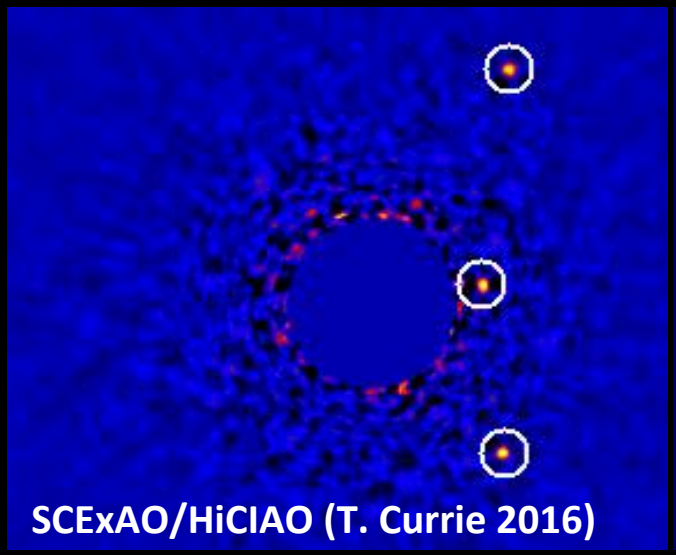
Current/Future SCExAO Science Instruments:

- Planet Imaging/Spectra: CHARIS integral field spectrograph
- Deep Planet Imaging: w/ Ultra-precise speckle cancellation and Imager: MEC camera

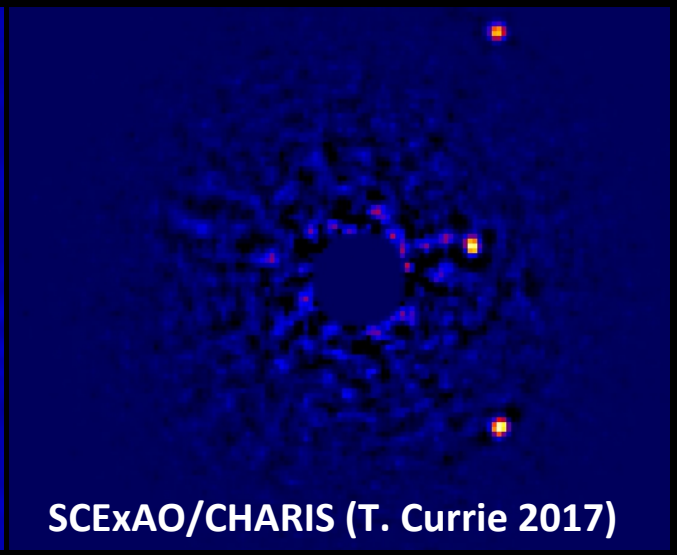


So how good is SCExAO?

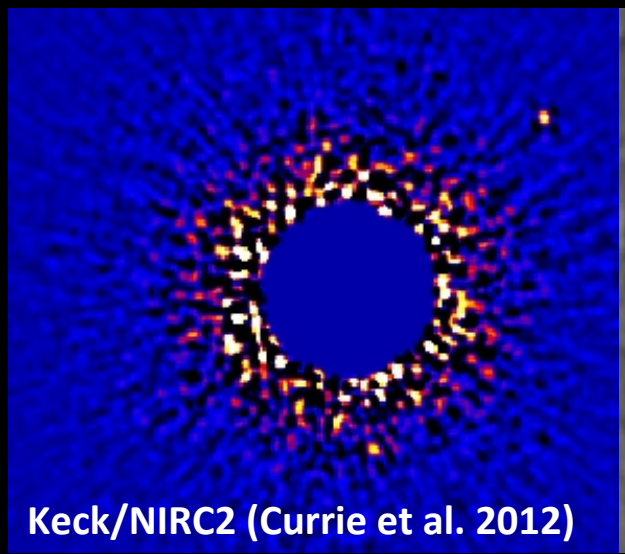
HR 8799: the acid test



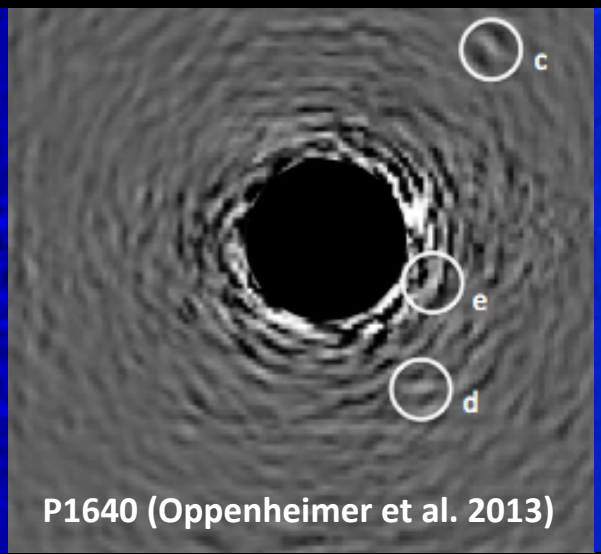
SCExAO/HiCIAO (T. Currie 2016)



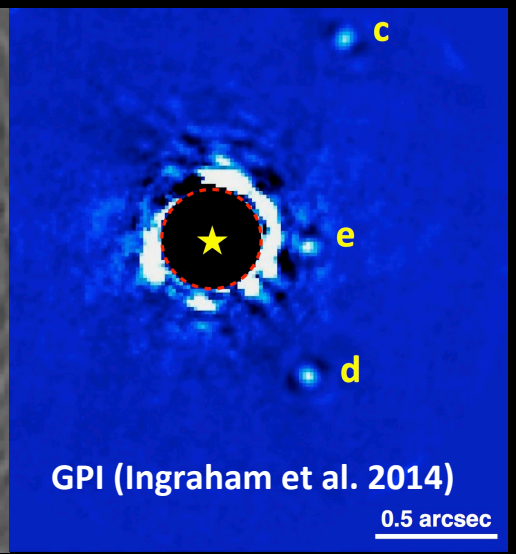
SCExAO/CHARIS (T. Currie 2017)



Keck/NIRC2 (Currie et al. 2012)



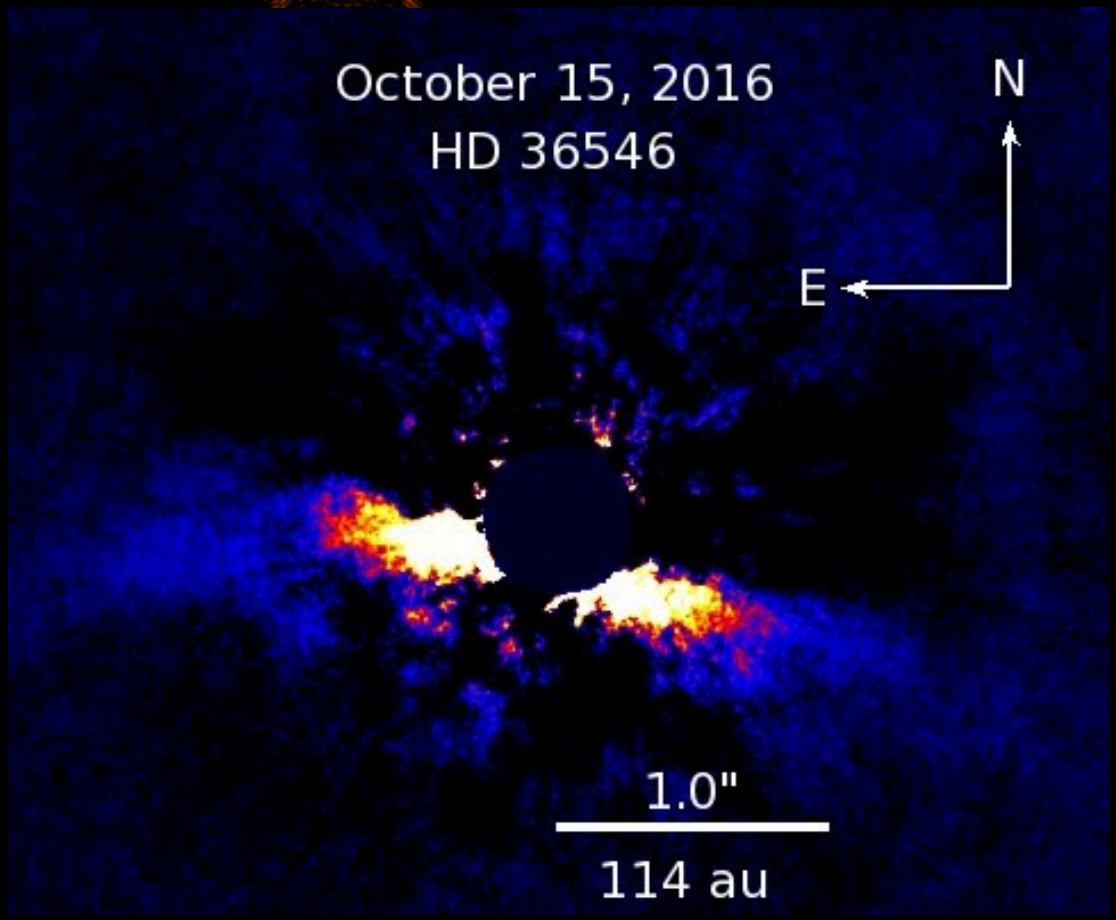
P1640 (Oppenheimer et al. 2013)



GPI (Ingraham et al. 2014)

0.5 arcsec

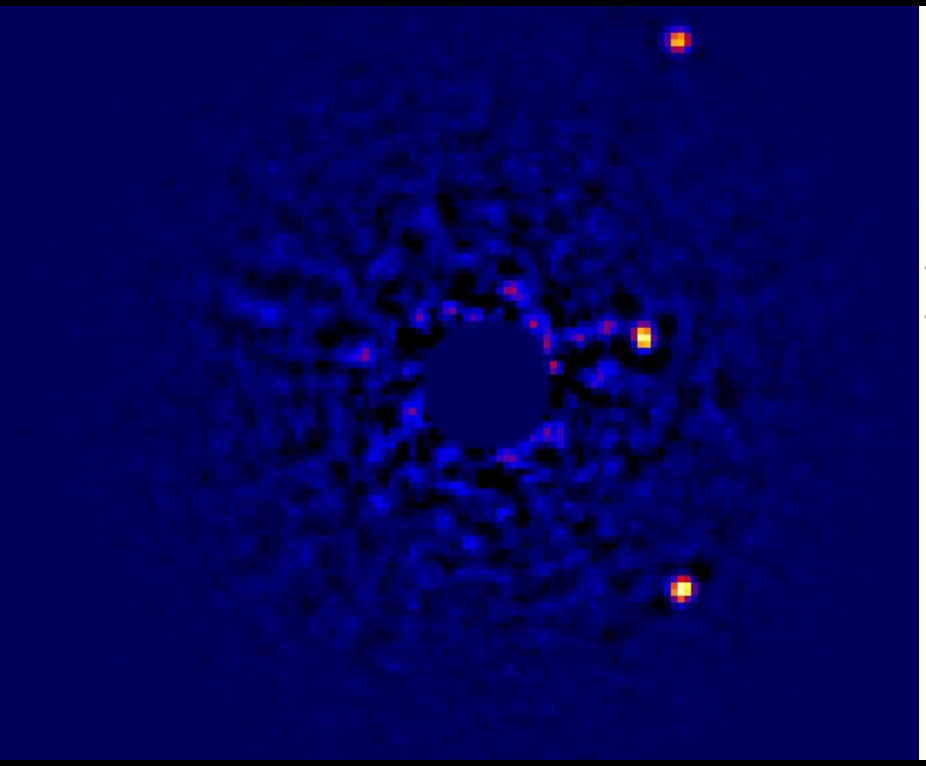
SCExAO Discoveries

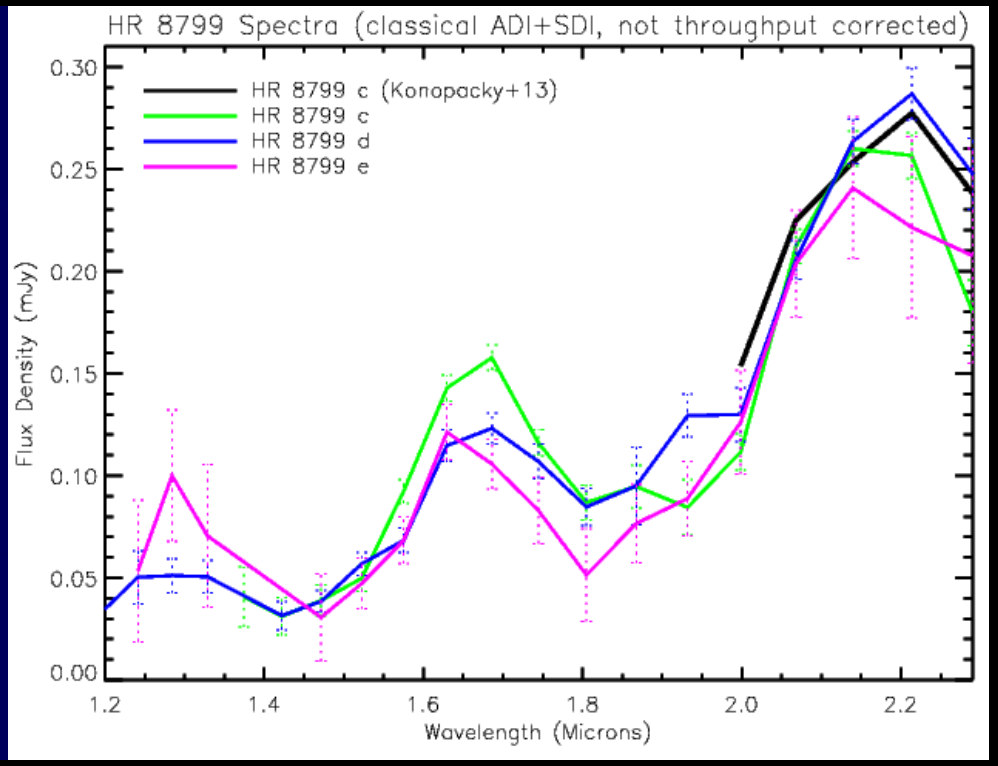


- One New Resolved Debris Disk, Multiple Planet/ Brown Dwarf Candidates at r < 1”

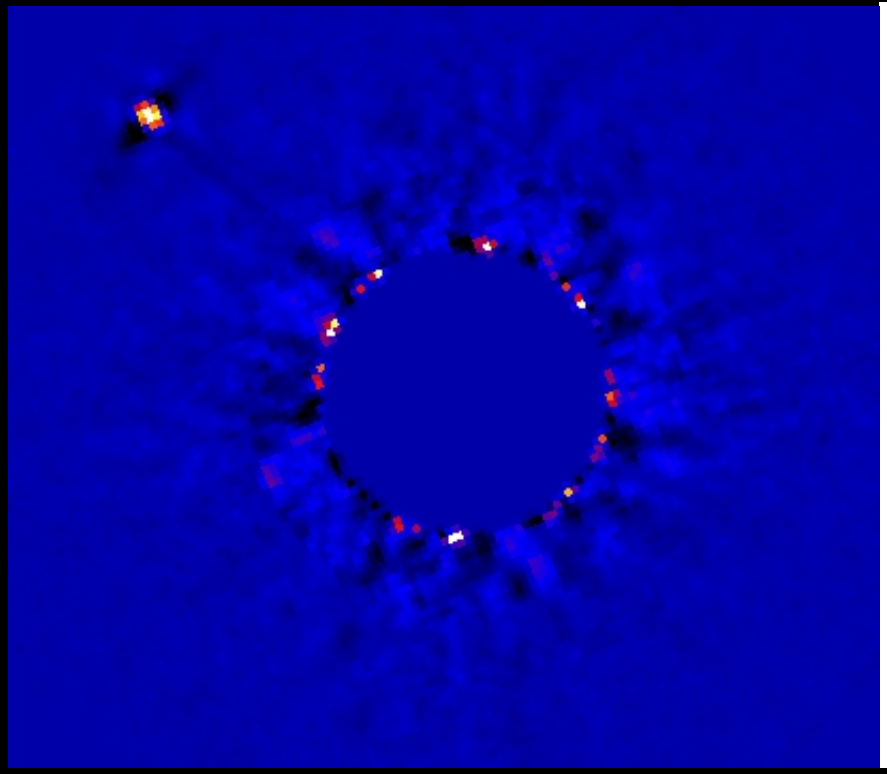
Currie, Guyon, and Tamura et al. (2017, ApJL)

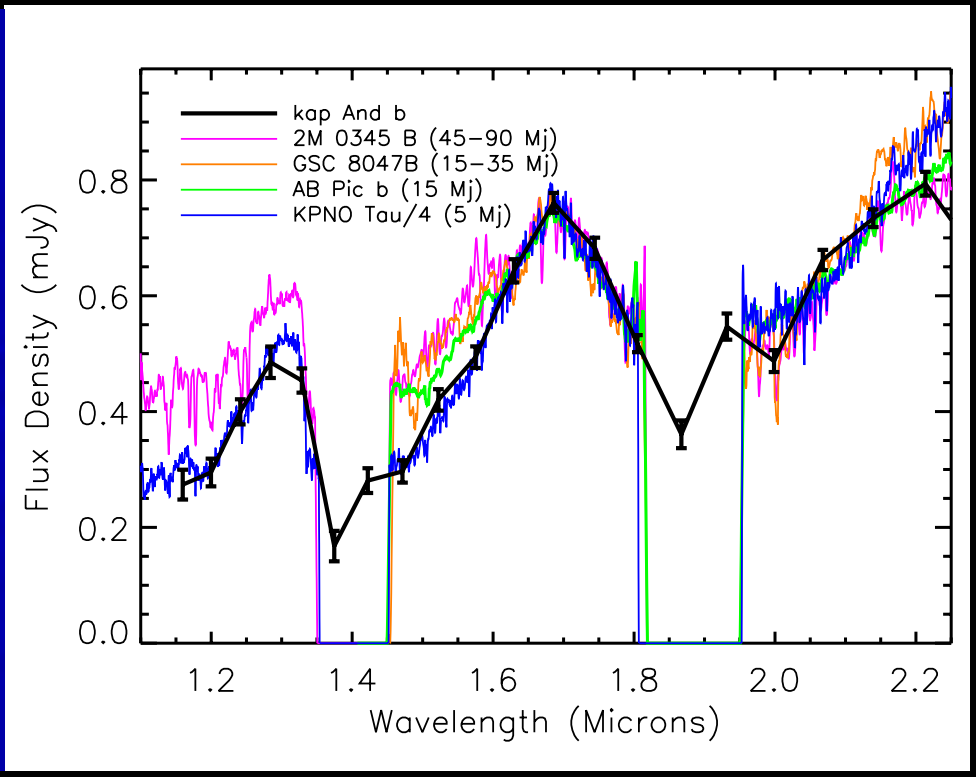
Exoplanet Spectroscopy with SCExAO



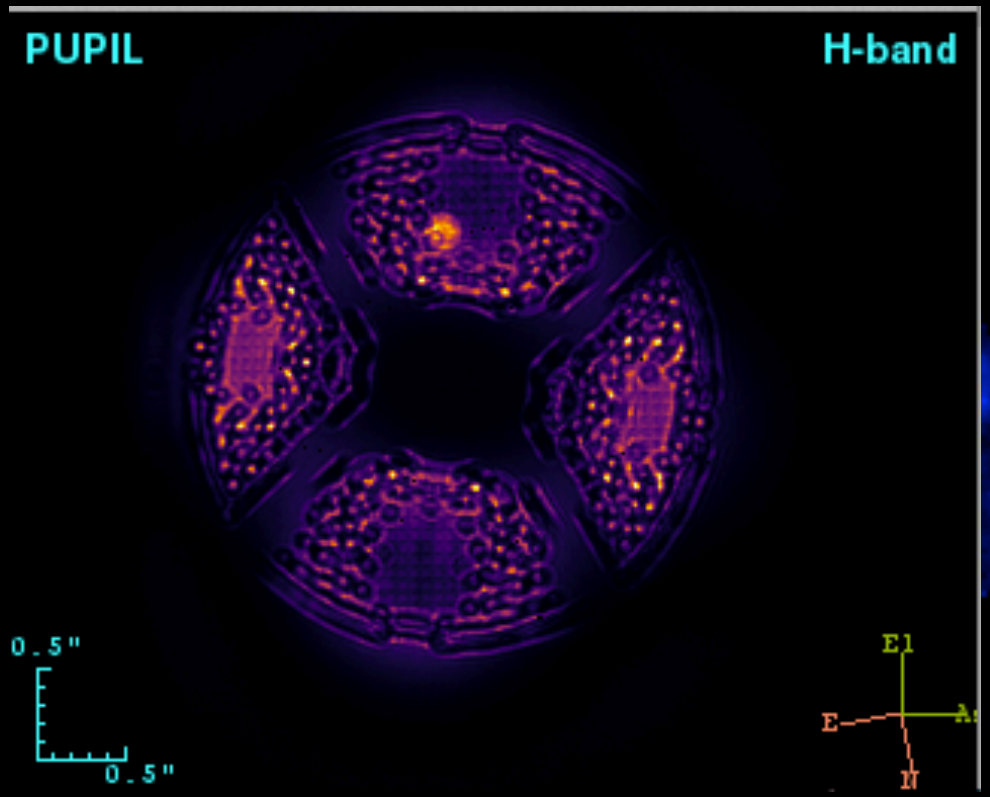


Exoplanet Spectroscopy with SCExAO

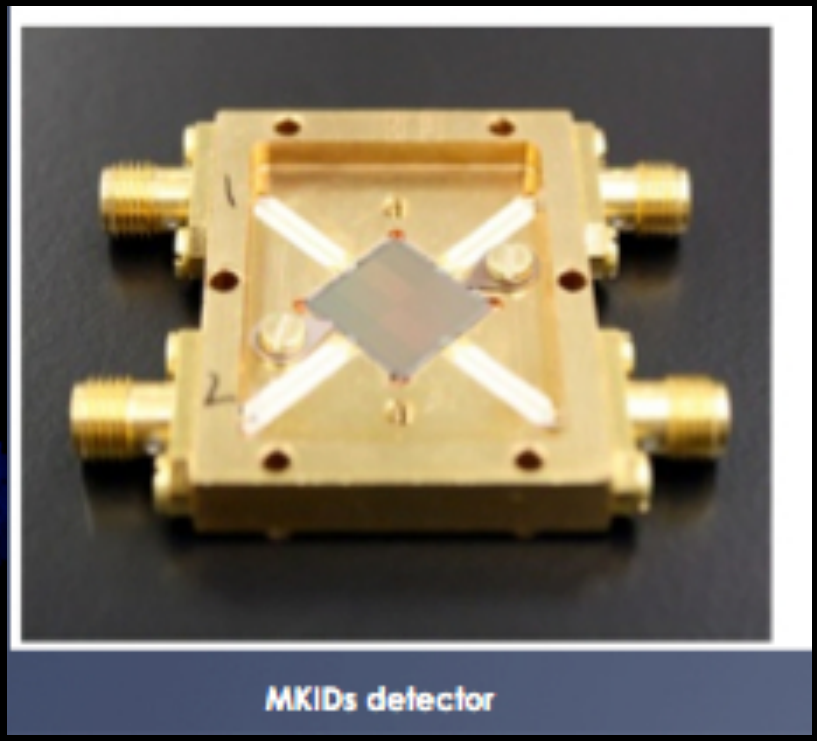




SCExAO: Testing New Exoplanet Imaging Technology



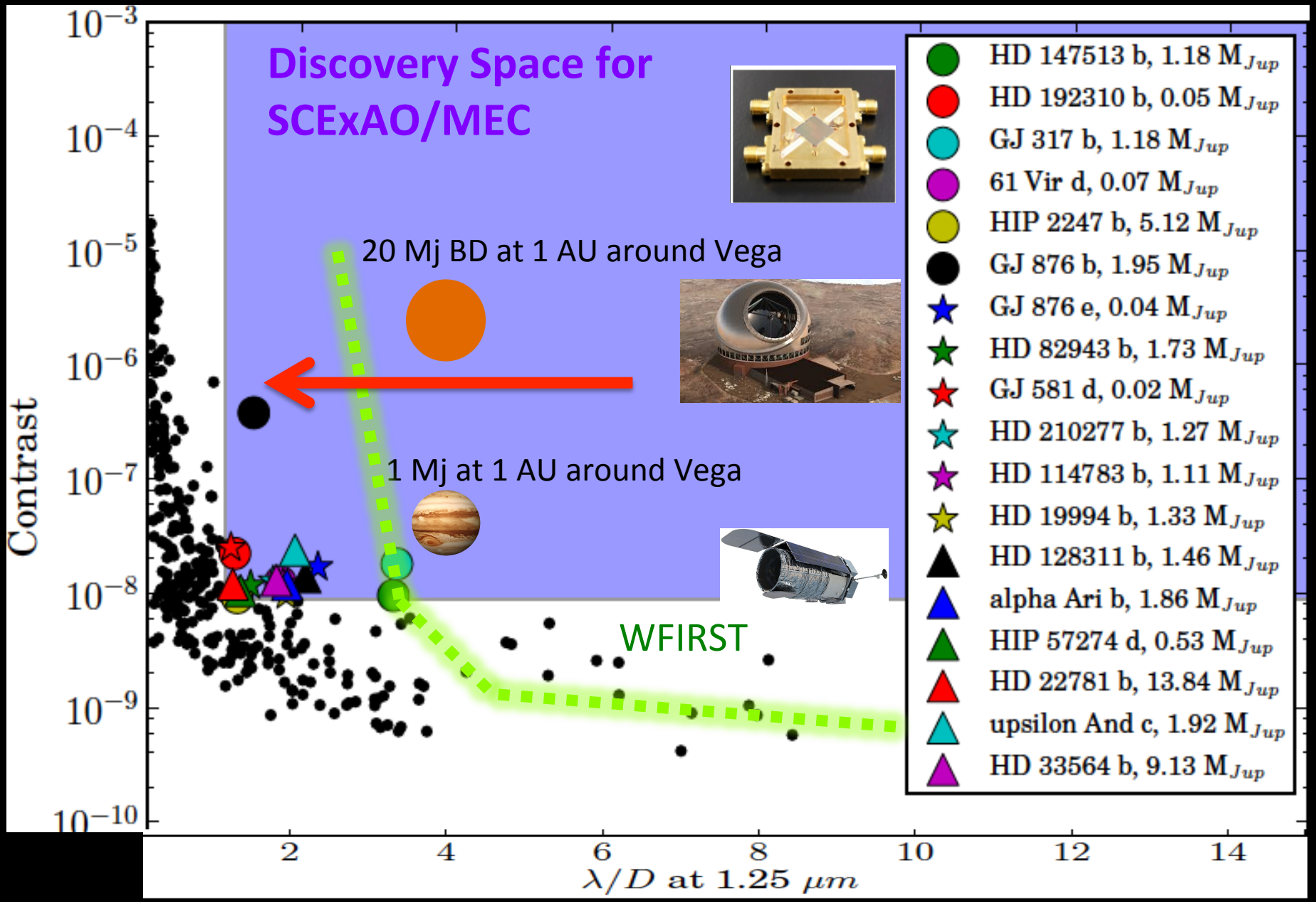
Shaped Pupil Coronagraph



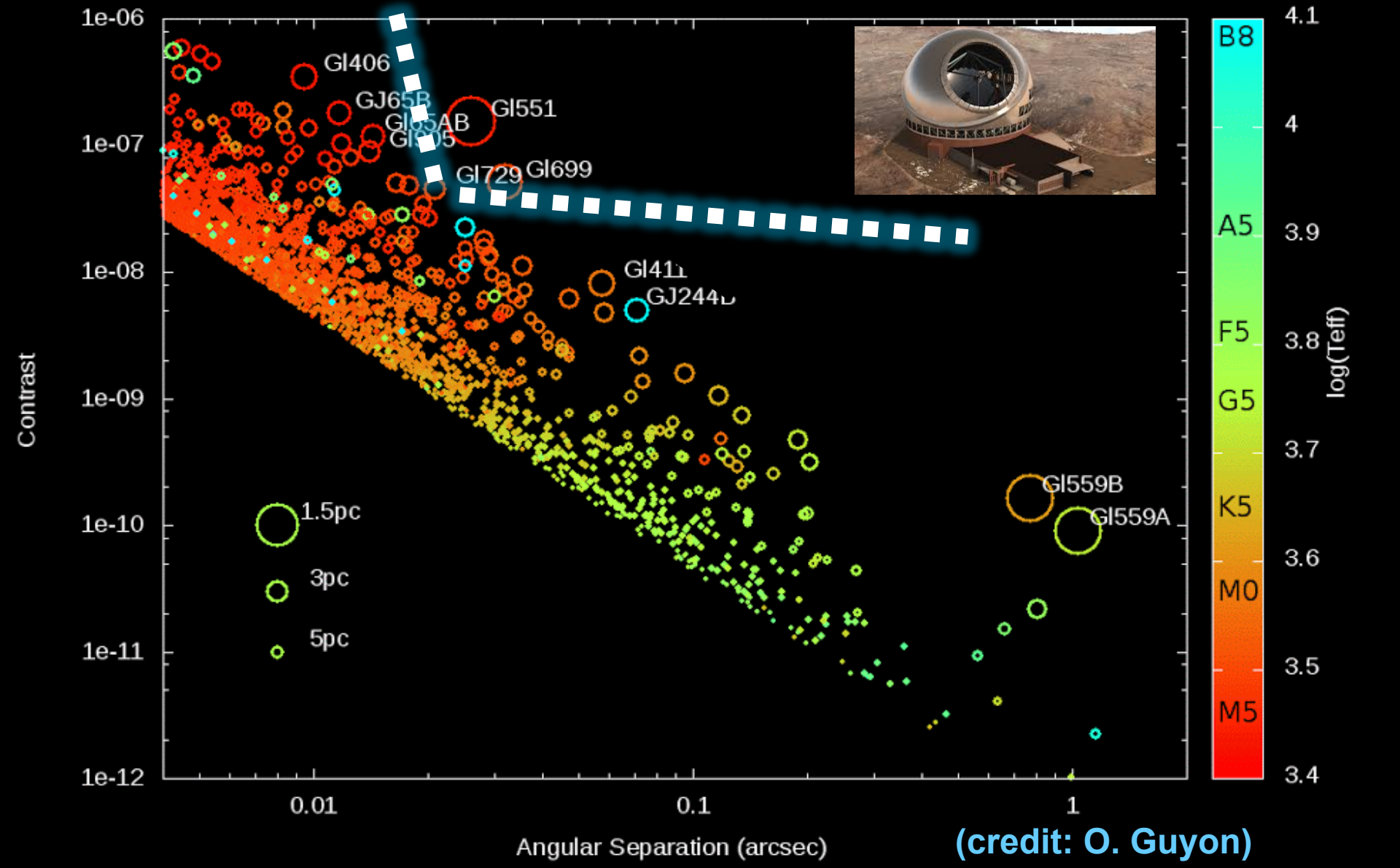
Focal Plane Wavefront Sensing + Speckle Control

Currie et al. (2017, in prep); Mazin et al. (2015)

SCExAO: Imaging Planets in Reflected Light

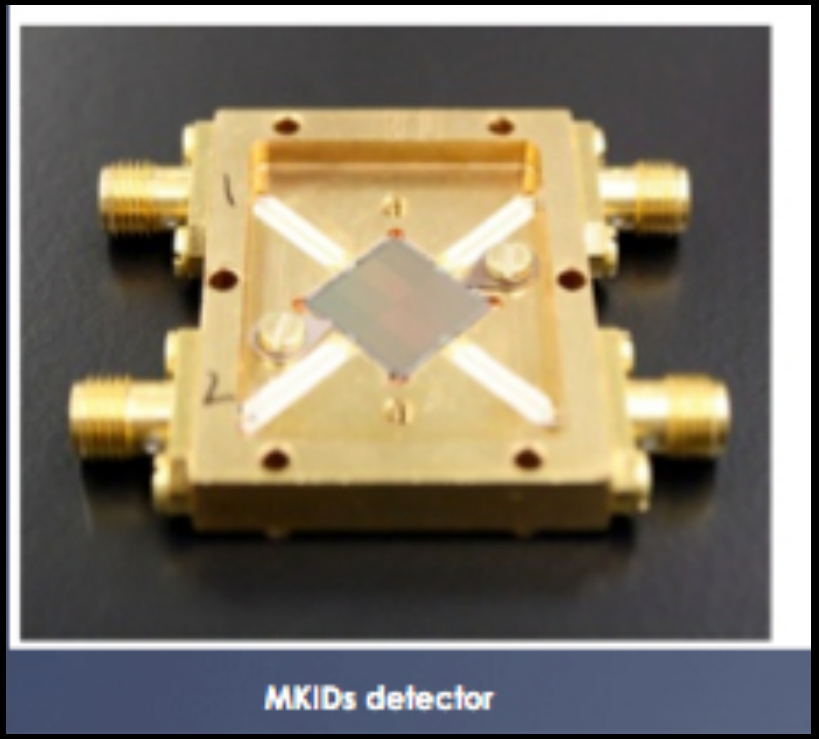


SCEXAO+ TMT: Imaging Rocky Planets

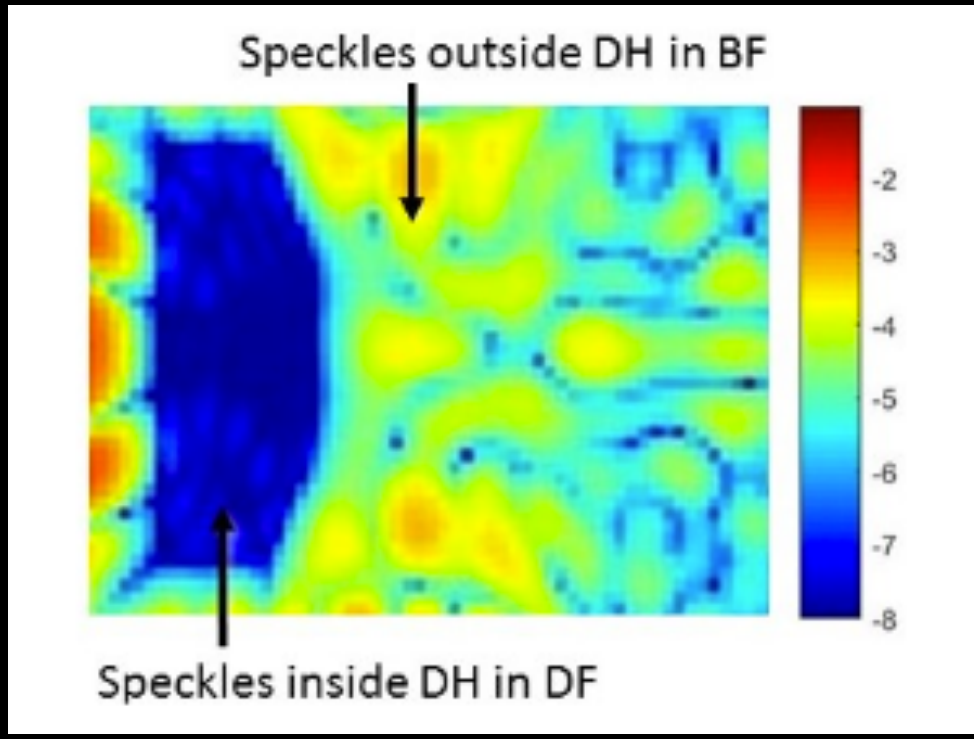


(credit: O. Guyon)

SCExAO: Testing New Exoplanet Imaging Technology



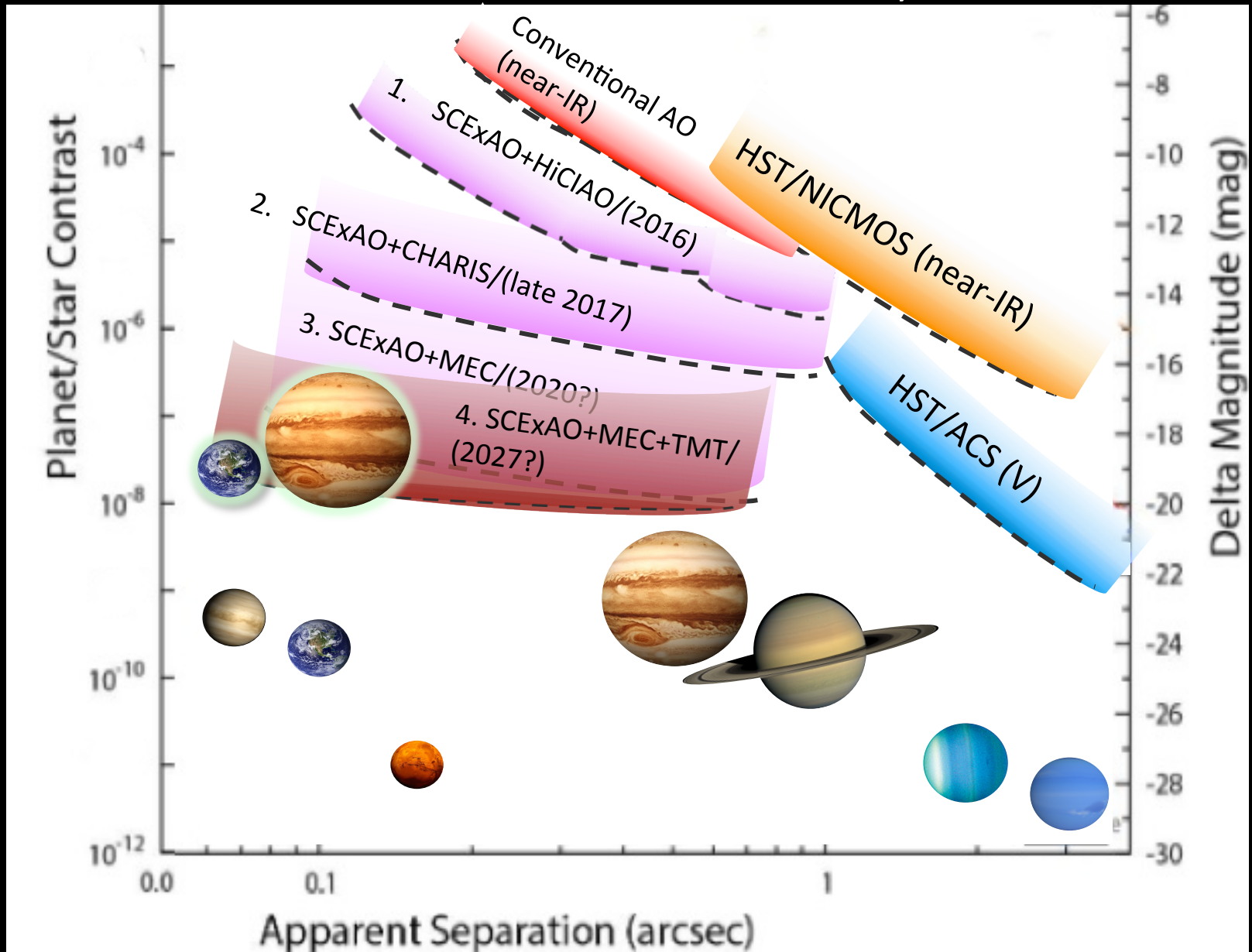
MKIDS/MEC Detector
(PI B. Mazin, UCSB)



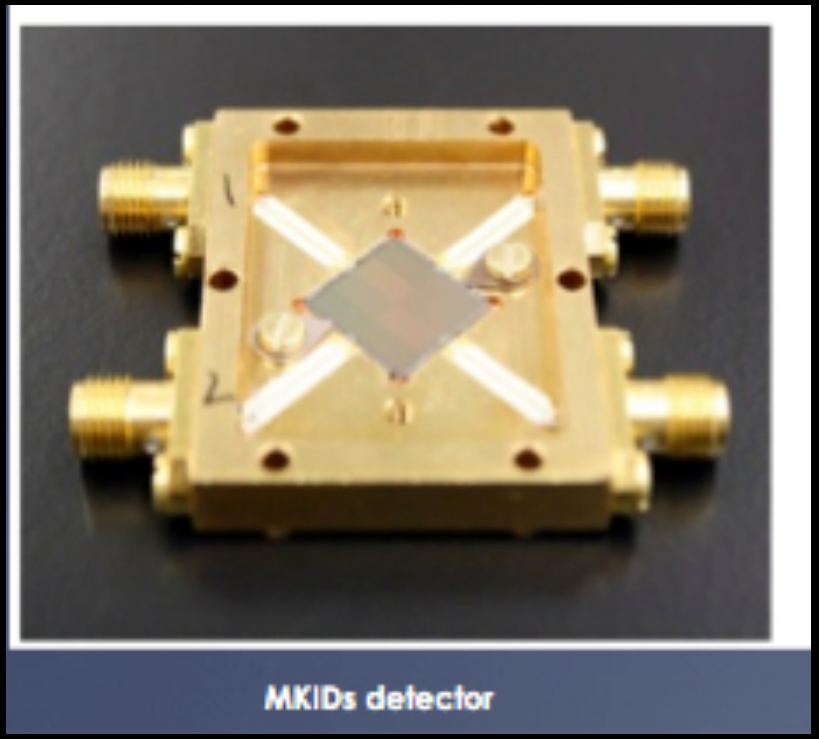
New Focal Plane Wavefront Sensing Approaches
(e.g. “Linear Dark Field Control”)

SCExAO : Towards Imaging Planets in Reflected Light

(Contrasts w/ Advanced PSF Subtraction)



SCExAO: Testing New Exoplanet Imaging Technology



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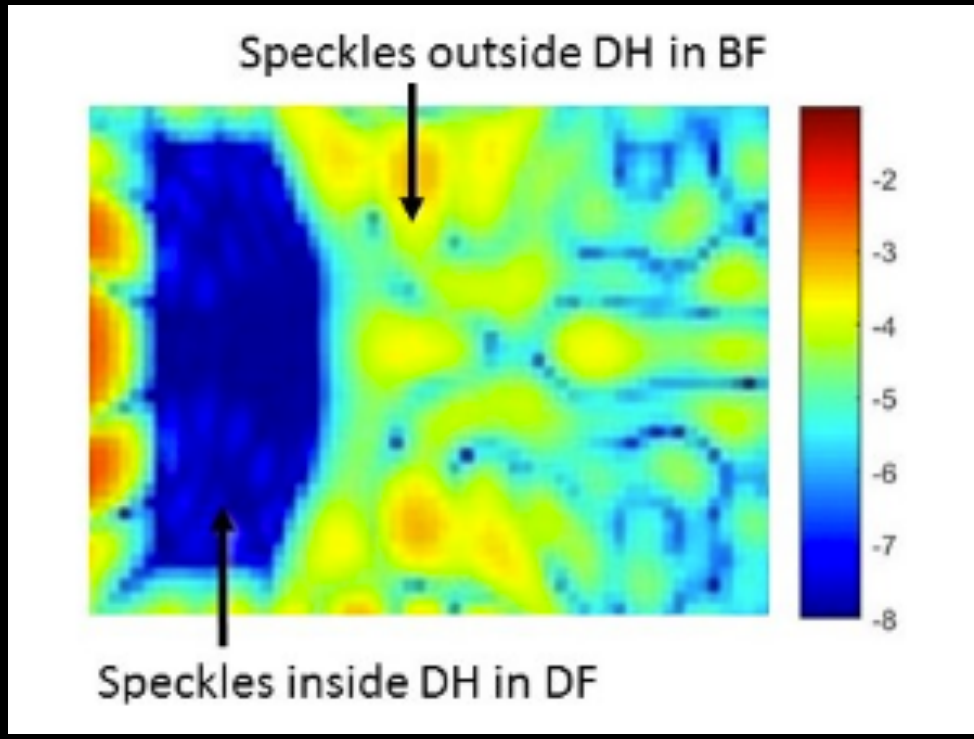


New Focal Plane Wavefront Sensing Approaches
(e.g. “Linear Dark Field Control”)

By the numbers

AO Performance (in good conditions)

- est. Strehl: 90+%, ~90%, and ~80% for R ~ 1-3, ~5-6, ~8-9
- Faint limit for extreme AO: R~12

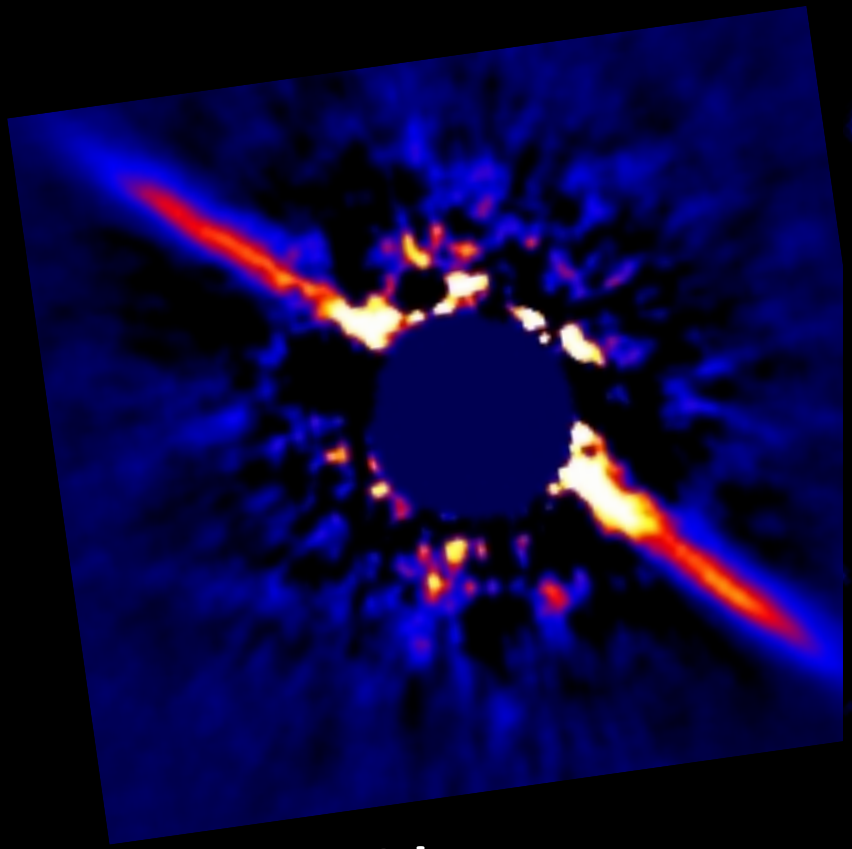
Achievable Contrast

- Raw Contrast (under good conditions): 1d-3, 1d-4, & 5d-5 at 0.1”, 0.4”, & 0.75”
- Contrast with post-processing (improving!): < 1d-5 at 0.4” and ~ 1d-6 at 0.75”

So how good is SCExAO?

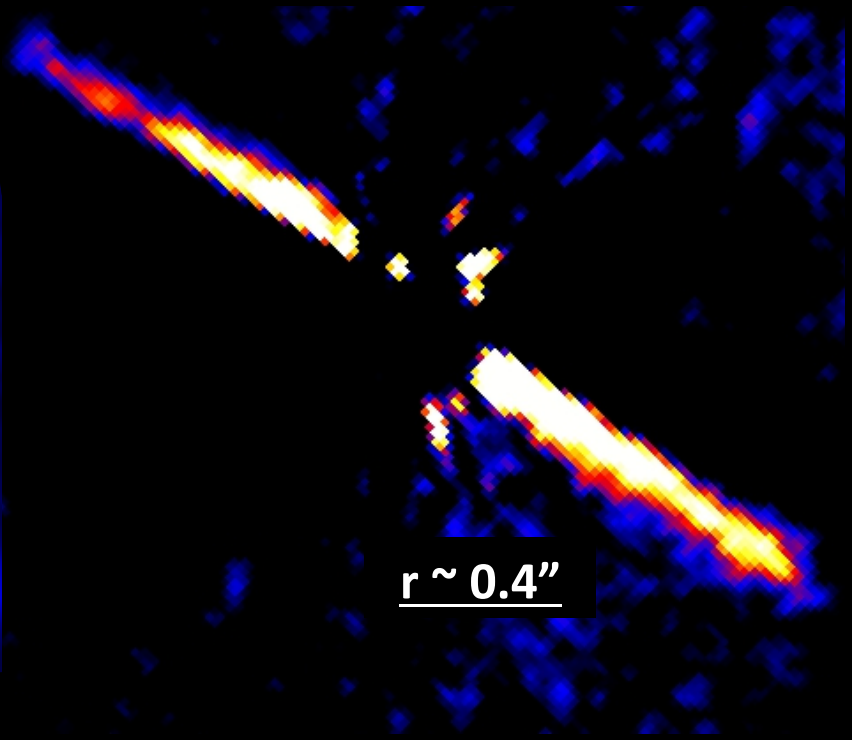
HD 32297

Keck/NIRC2
Currie et al. (2012)



~1 hour

SCExAO/CHARIS
(T. Currie 2017, in prog.)



~1 minute