A deep search for giant, self-luminous planets in dusty systems on Solar System scales

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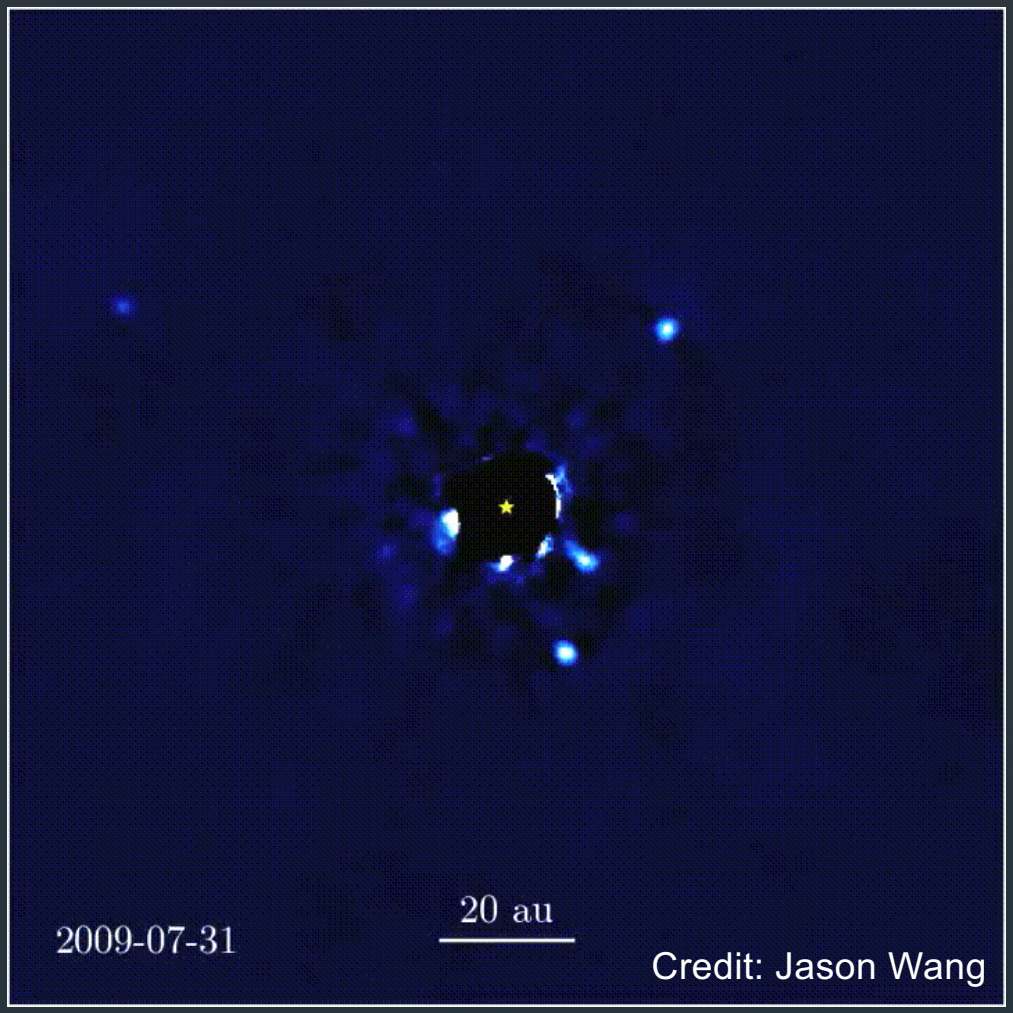
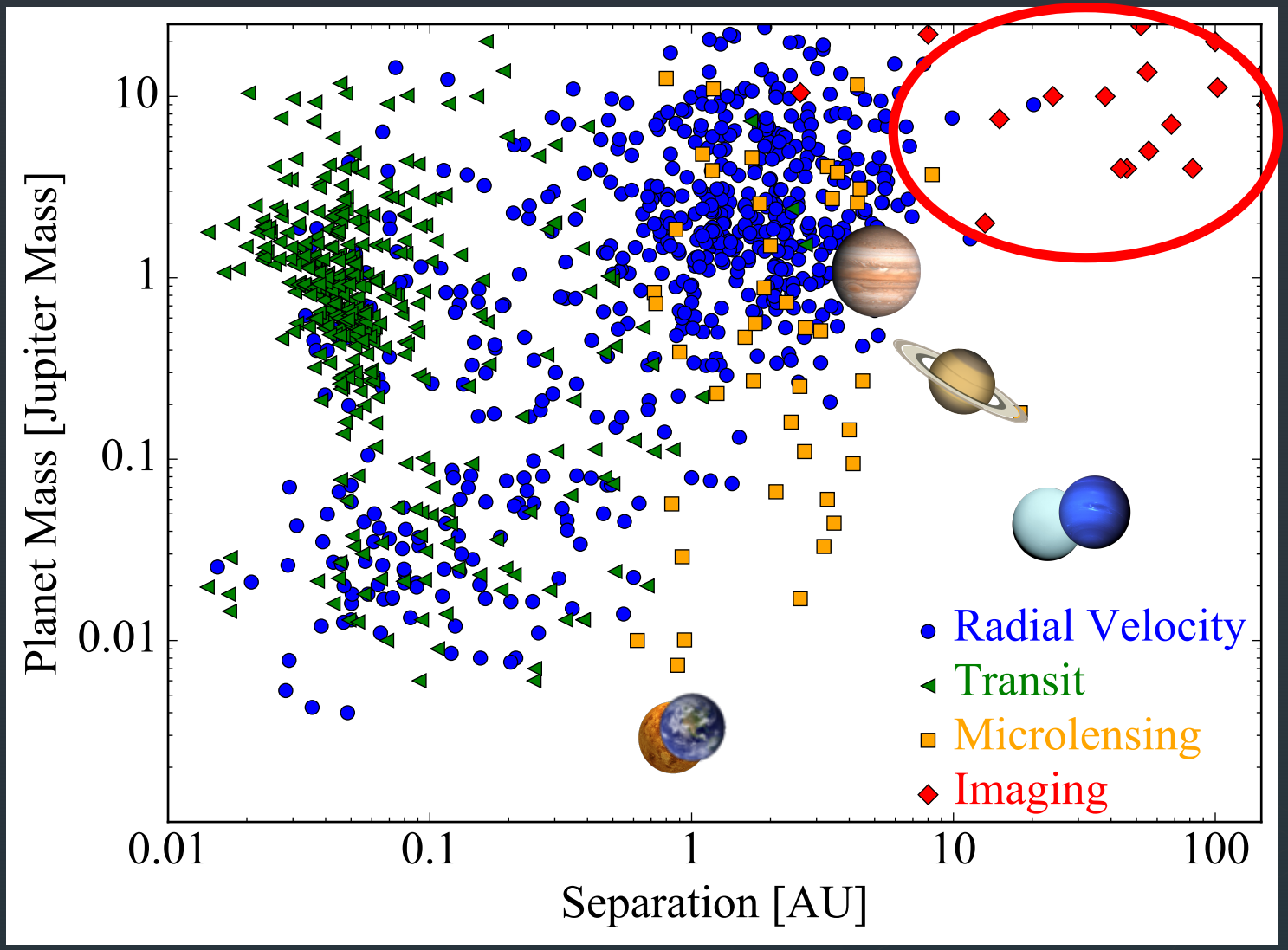
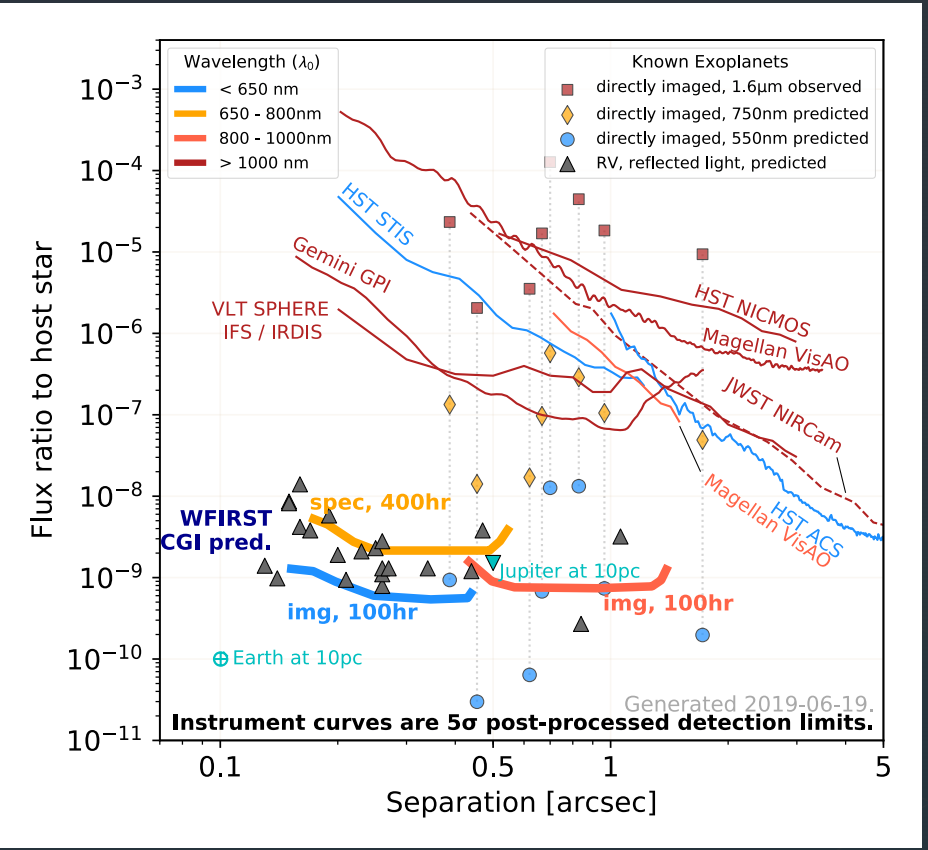
Direct Imaging





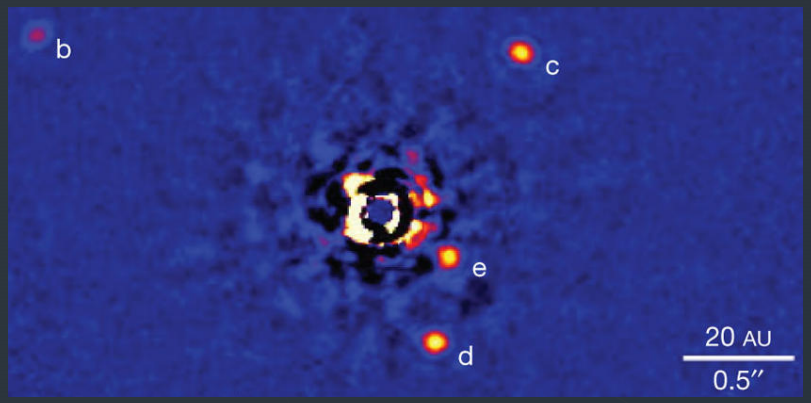
Data from NASA Exoplanet Archive

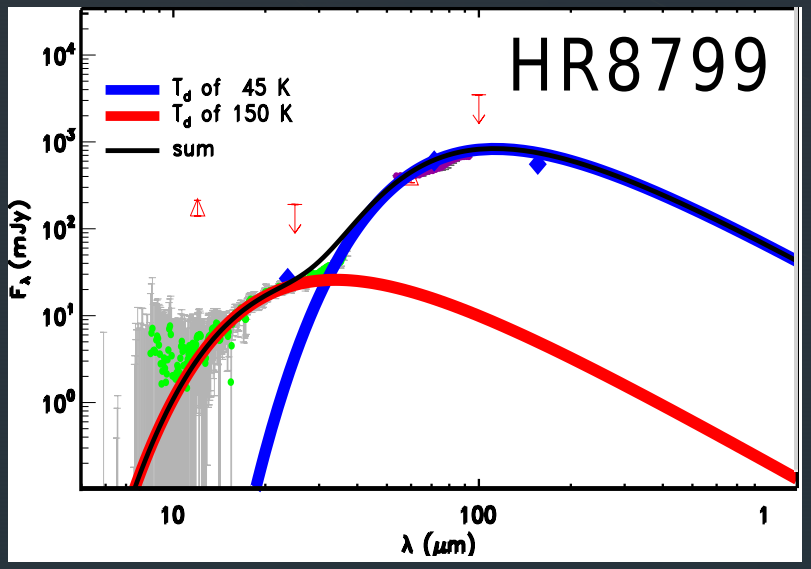
Self-luminous planets as targets for WFIRST CGI



Credit: Vanessa Bailey

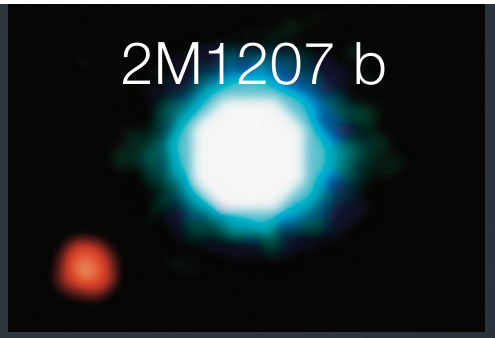
Motivation for finding planets in debris disks

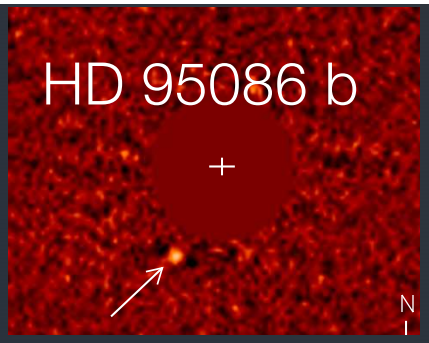


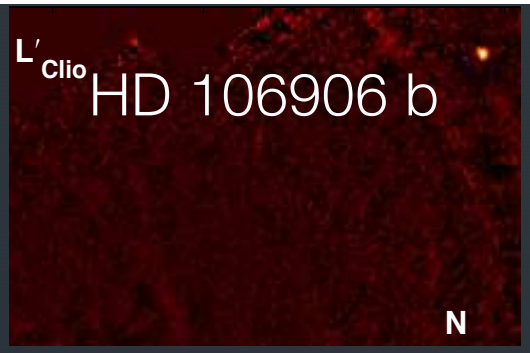


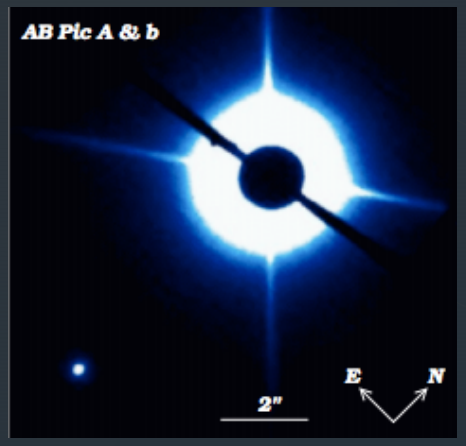
Su et al. 2013

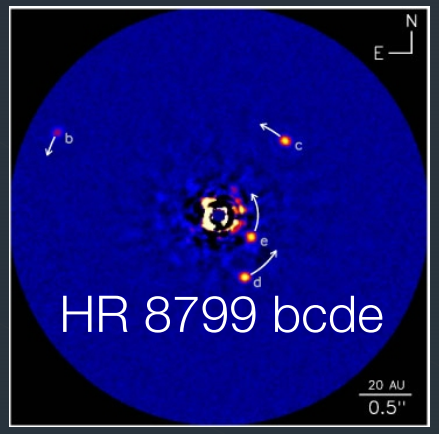
HR 8799

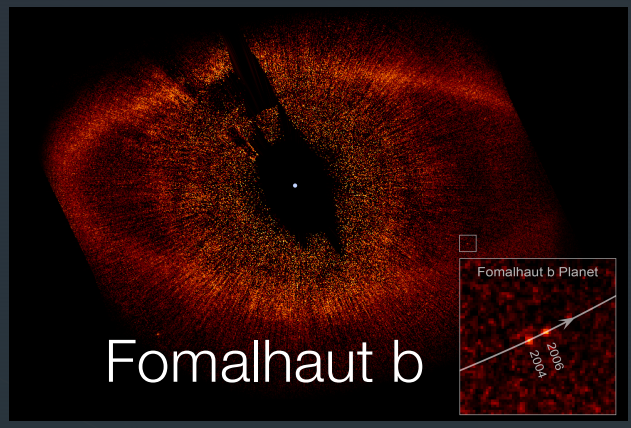

2M1207 b

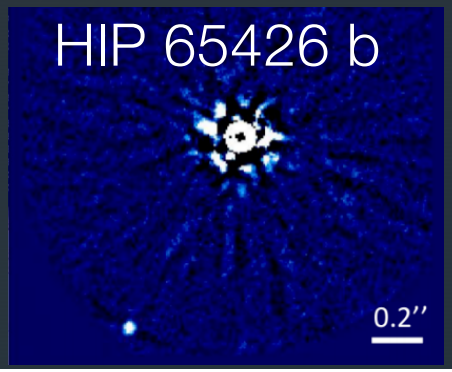

HD 95086 b
N

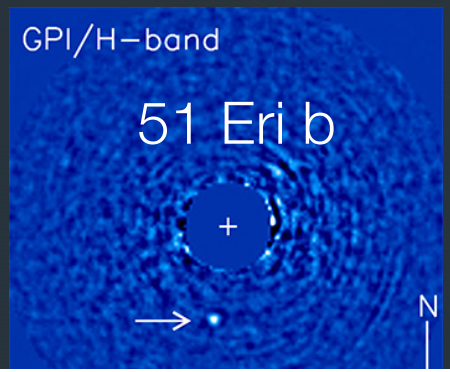

L′Clio
HD 106906 b
N

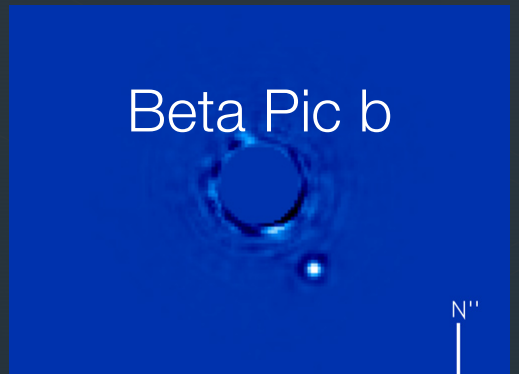

AB Pic A & b
2″
E
N


N
E
b
c
e
d
HR 8799 bcde
20 AU
0.5″


Fomalhaut b
Fomalhaut b Planet
2006
2004


HIP 65426 b
0.2″


GPI/H−band
51 Eri b
N


Beta Pic b
N″

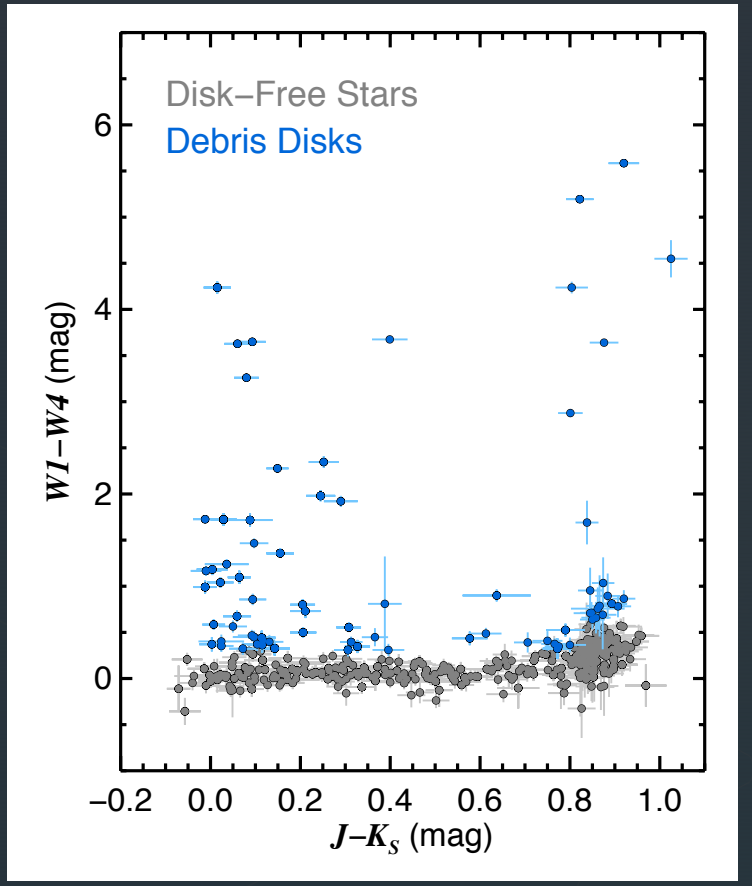
Debris disk sample and control sample

- 130 debris disk stars

(including new data from 30 Spitzer targets and Wahhaj et al. 2013, Rameau et al. 2013, Janson et al. 2013)

- 277 control sample stars

(data from Biller et al. 2013, Bowler et al. 2015, Brandt et al. 2014, Galicher et al. 2016, Lafreniere et al, 2007, Nielsen et al. 2013, Vigan et al. 2012)

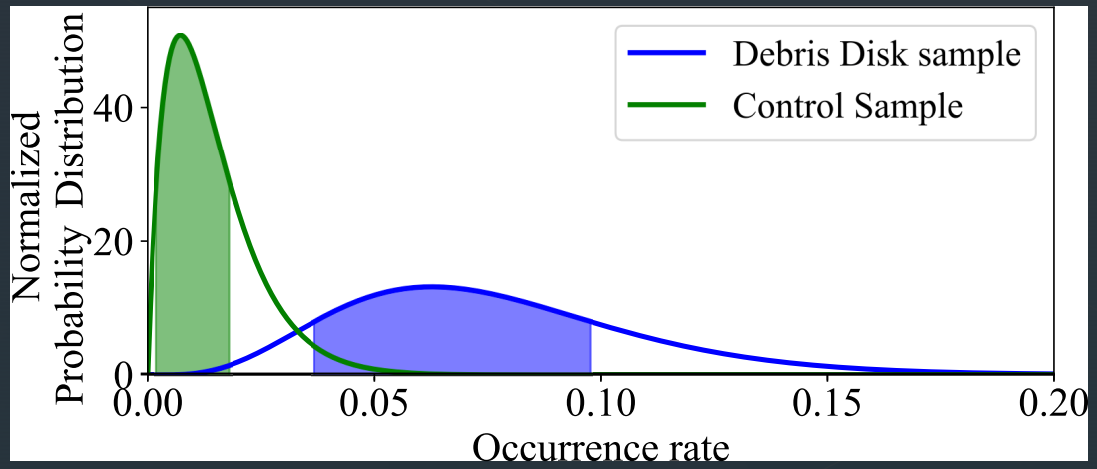


Meshkat et al. 2017

Giant planets are more common around stars with debris disks

Table 5
Occurrence Rates for Companions (5-20 $M_{\rm Jup}$ and 10-1000 AU) at the 68% confidence level (CL).

	Debris Disk	Control Sample
Full Sample	6.27%, 68CL 3.68-9.76%	0.73%, 68CL 0.20-1.80%
Early-type	9.94%, 68CL 5.82-15.16%	–, 68CL 0-4.17%
Late-type	–, 68CL 0-4.61%	2.18%, 68CL 0.57-5.22%



Meshkat et al. 2017

New Keck survey target selection

- 40 of the brightest (W1<7.5 mag) and nearest (d<50 pc) stars with debris disks identified from their thermal IR excesses:
  - Well-known young (<600 Myr) stars for which large excesses have been detected by IRAS and Spitzer.
  - New disk targets discovered using WISE (Patel et al., 2014, 2017), and for which the one or two IR excess fluxes at 12 and 22 microns is insufficient to constrain the disk brightness. We relaxed our age restriction for these targets to <800 Myr.

Target selection (2)

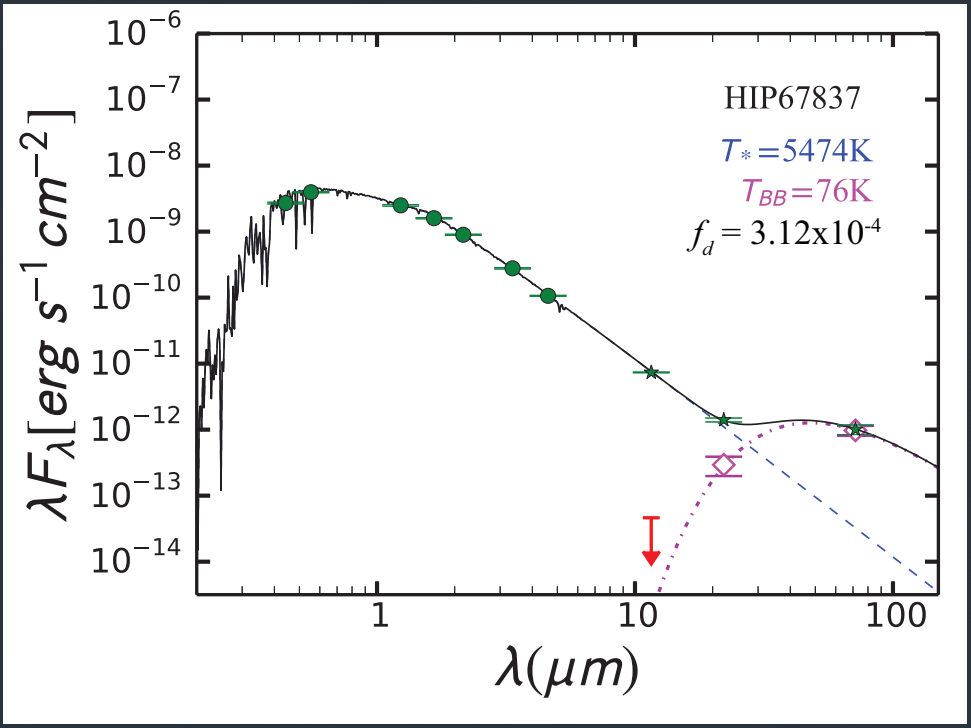
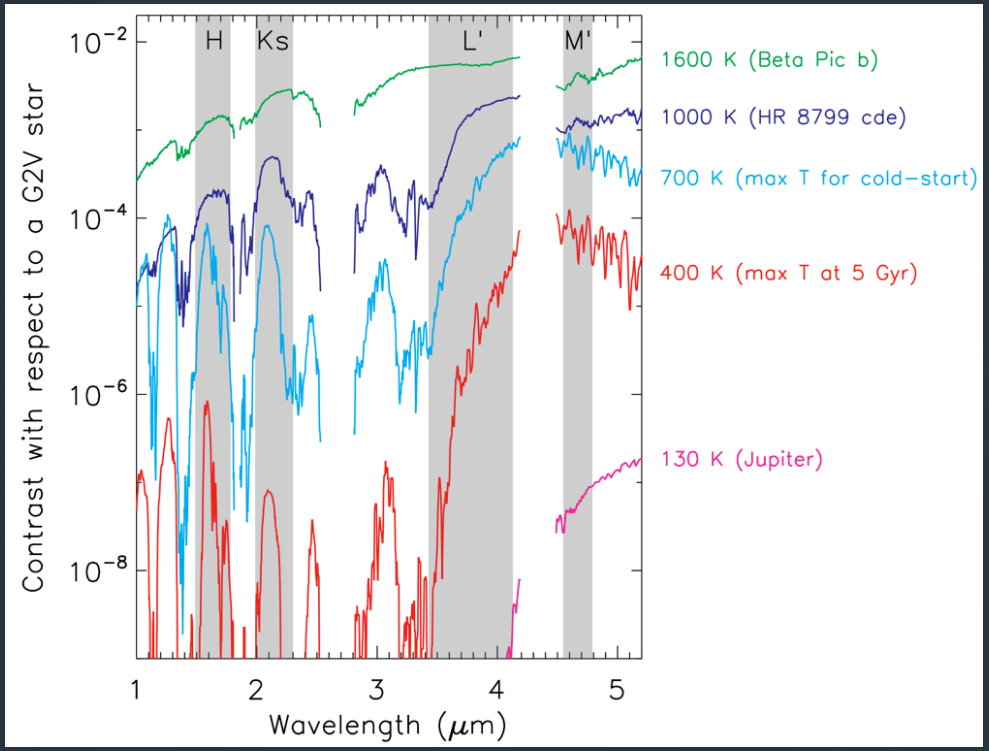


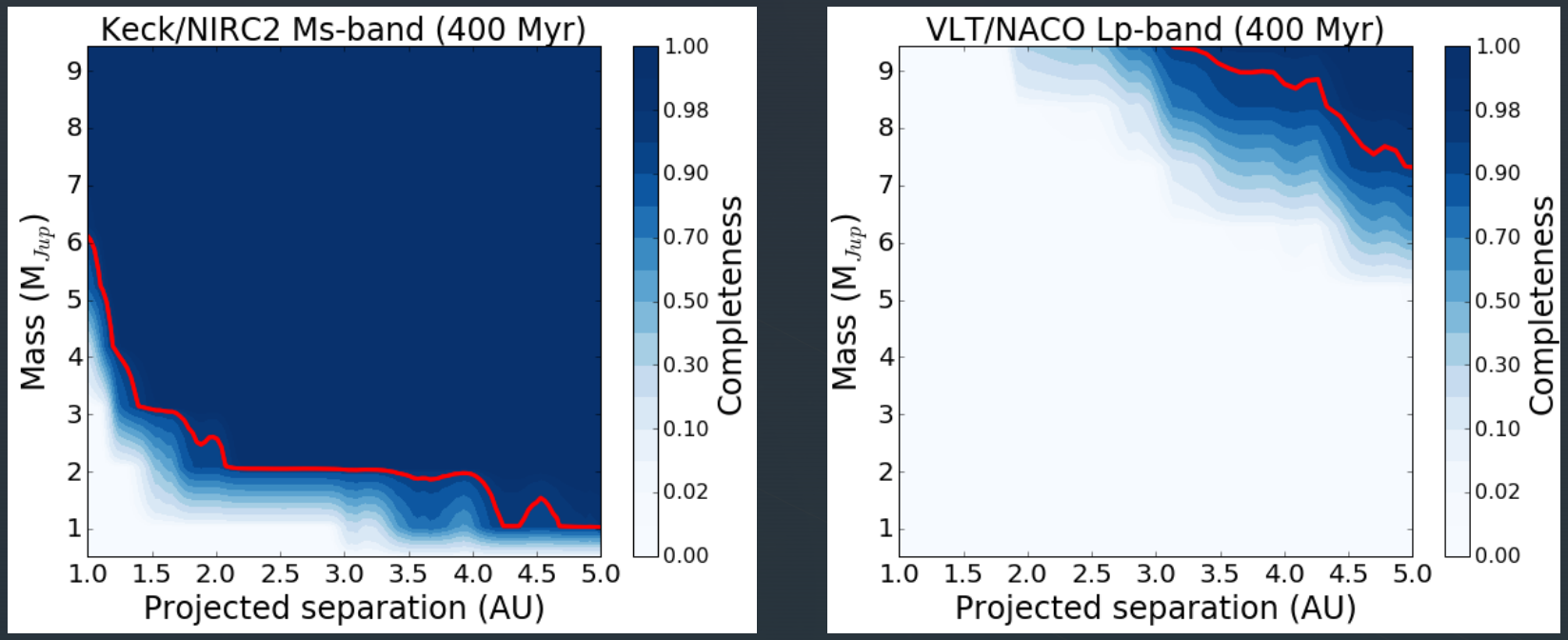
Figure 10 from Patel et al. (2017) showing an example SED of newly detected infrared excesses

The gain of L and M-band

- L'-band (3.8 micron) and Ms-band (4.7 micron) have a gain over shorter wavelengths to detect planets at temperatures colder than 700K, opening up the parameter space to older systems of a few hundred Myr.



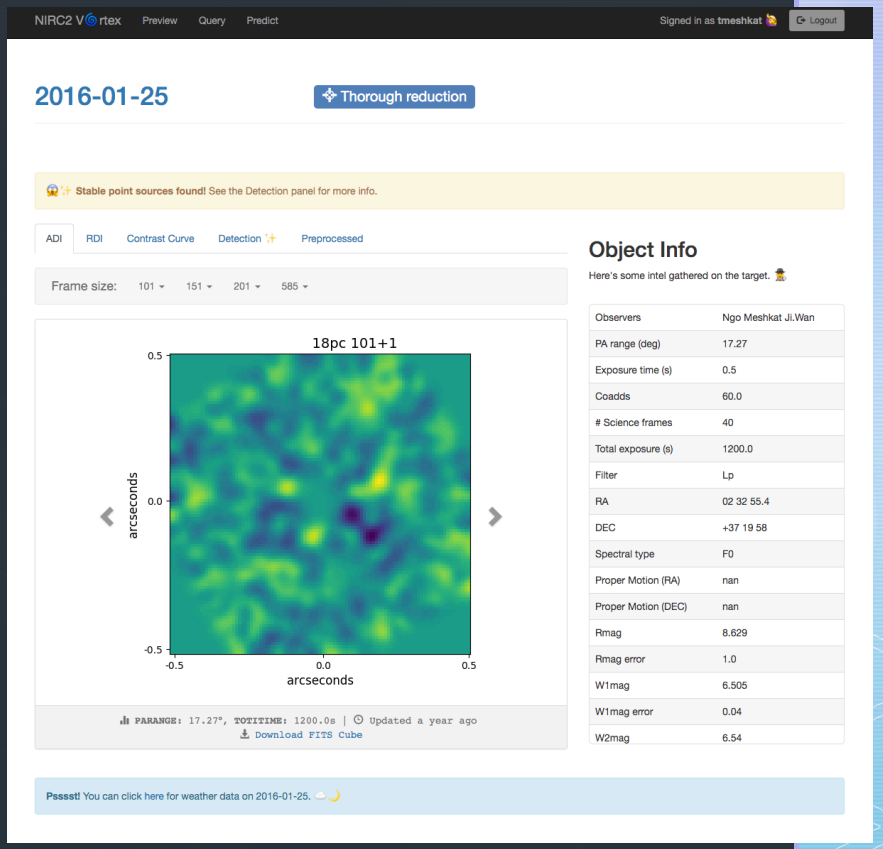
Gains from Keck/NIRC2 vortex coronagraph and L'+Ms-band



Adapted from Mawet et al. (2018) *submitted* Figures 4 and 5, comparing the sensitivity achieved by the Keck/NIRC2 Ms-band (Left) to VLT/NACO L'-band (Right).

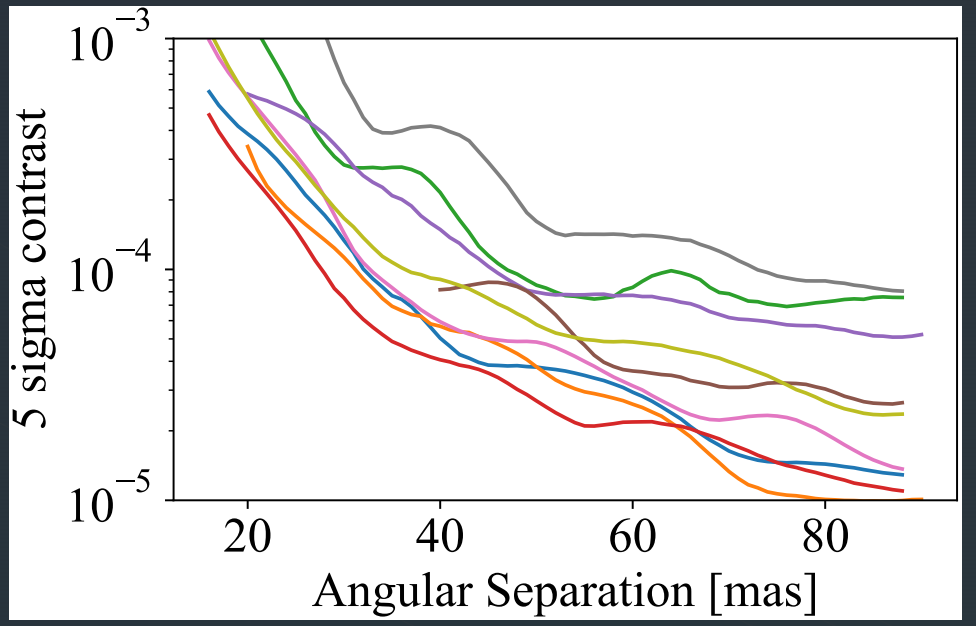
Status of Survey

- Deep observations of well selected list of targets
- 75% of targets observed in 2017B, 2018A, 2018B, and now in 2019A (PI Mawet).
- All data are processed through an automatic pipeline, developed in-house



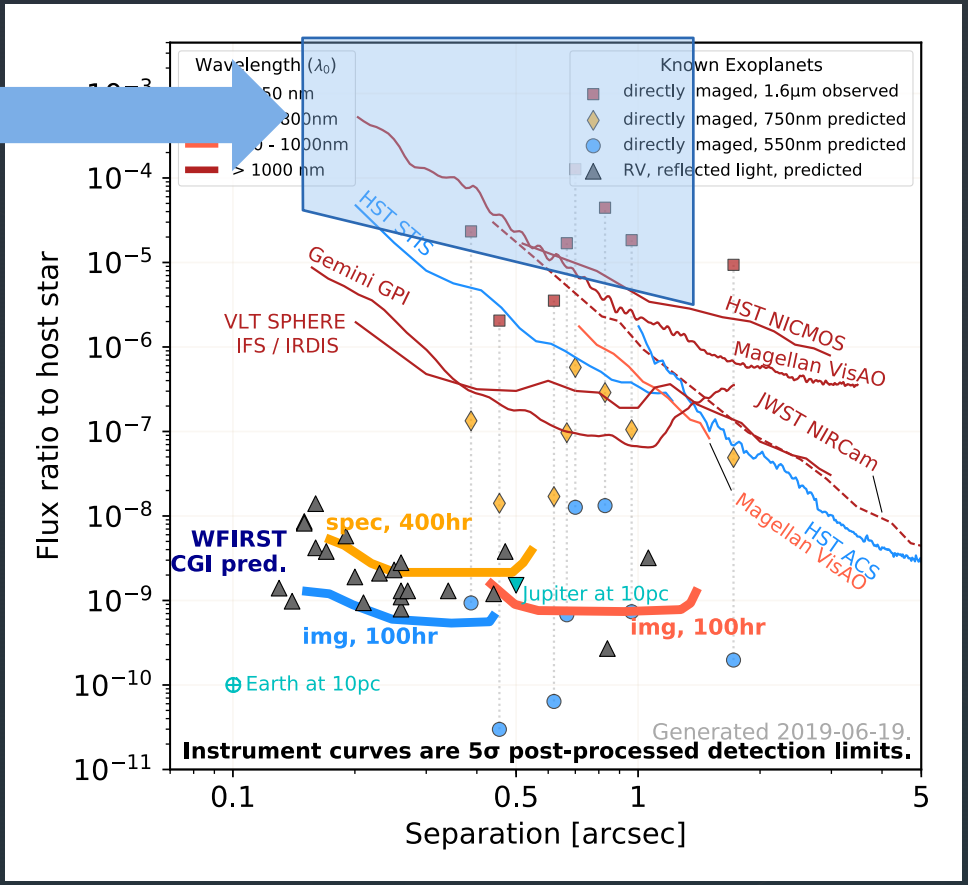
Status of survey (2)

- Currently following up a two interesting point sources (potentially low mass substellar companions) and potential disks detections
- Based on occurrences from Meshkat et al. (2017), we expect to find between **1-4 new giant exoplanets.**



New self-luminous planets could provide exciting targets for WFIRST CGI

New planet discovery space with our Keck survey



Credit: Vanessa Bailey

Summary

- Survey is ongoing, obtaining last datasets in 2019A and 2019B.
- We expect to discover 1-4 new giant exoplanets.
- New self-luminous planets provide interesting new targets for follow-up with WFIRST CGI
  - Nicely overlaps with FOV of CGI
  - Self-luminous planets are likely to be within predicted CGI detection and characterization limits