

Coronagraph requirement discussion

Topics

- Coronagraph requirement setting (Macintosh)
- Science figure of merit process (Traub)
- Open discussion
- Timetables and actions

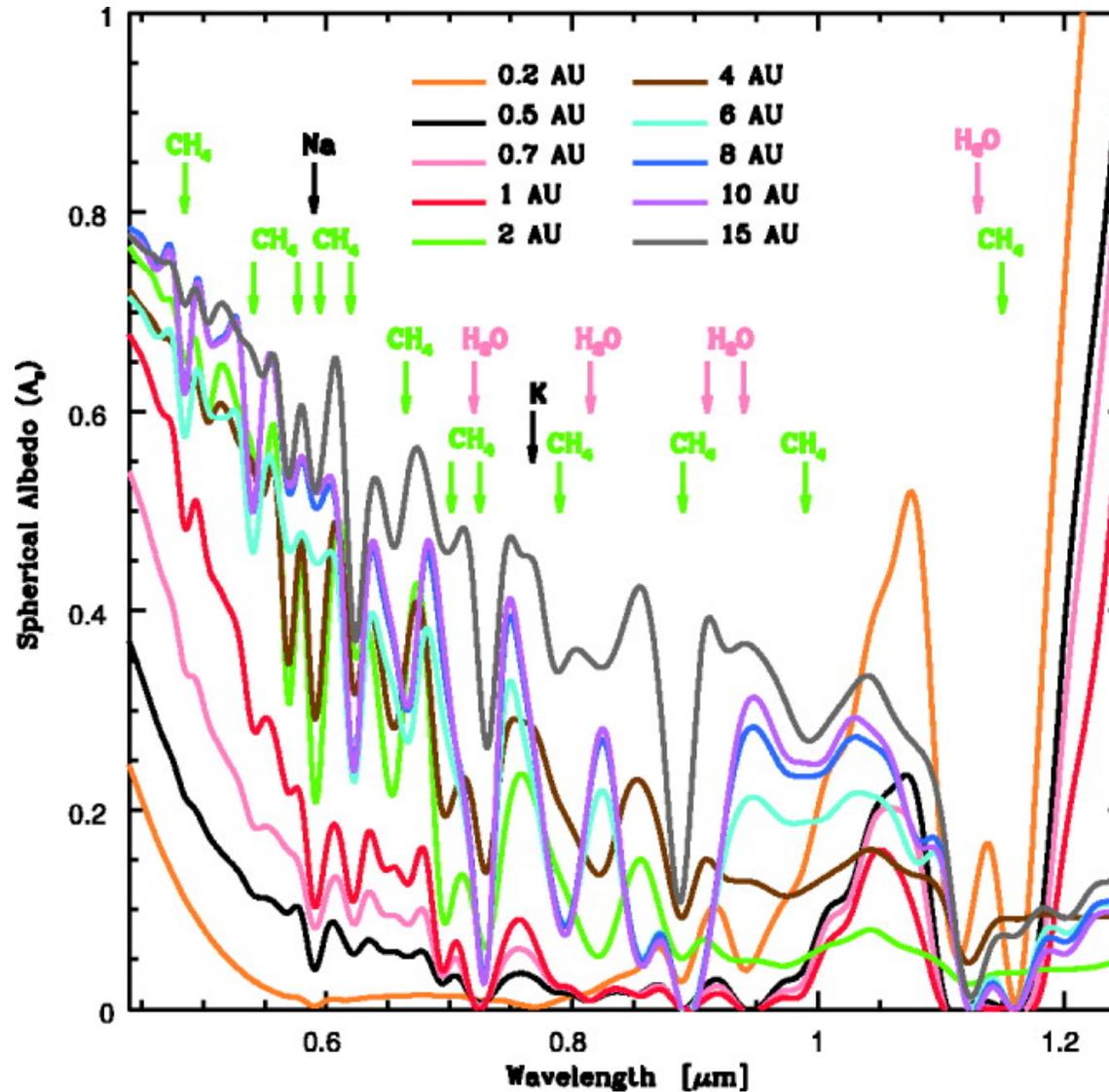
Key questions

- How do we make requirements objective properties of the instrument?
- How far down do we define requirements?
- What requirements are most set?
- How do we allow trades?
- Distinguish “requirements” from “figures of merit”

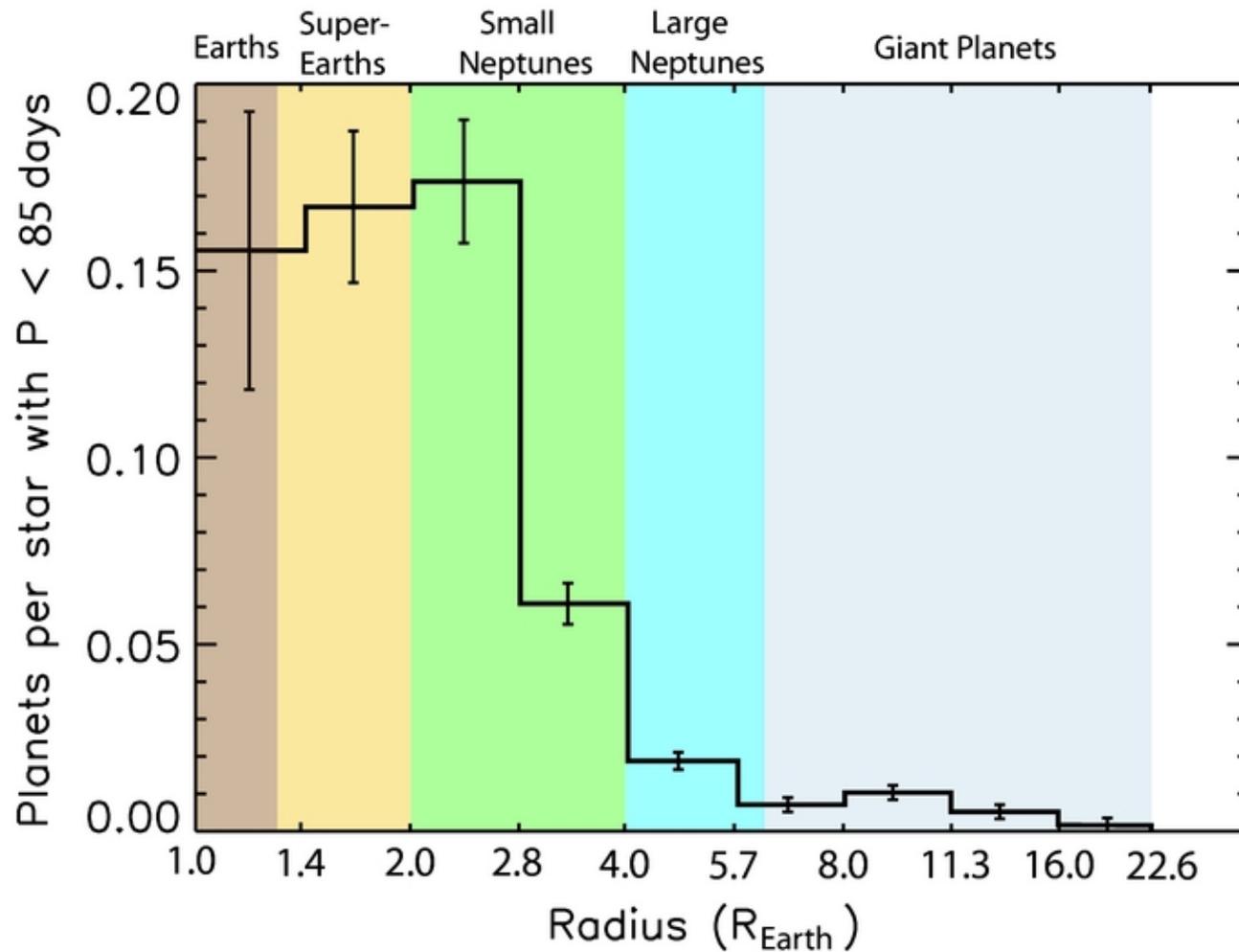
Science Questions

- What is the atmospheric structure of warm giant planets?
- What is the composition of giant planets and what does that imply about their formation mechanism?
- What is the nature of (some of) the 1-3 RE exoplanet population discovered by Kepler?
 - What does that imply about the number of rocky planets?
- What systems (individually or statistically) in the solar neighborhood are suitable targets for future terrestrial-planet characterization?

Exoplanet spectra (Sudarsky et al 2005)



Kepler radius distribution

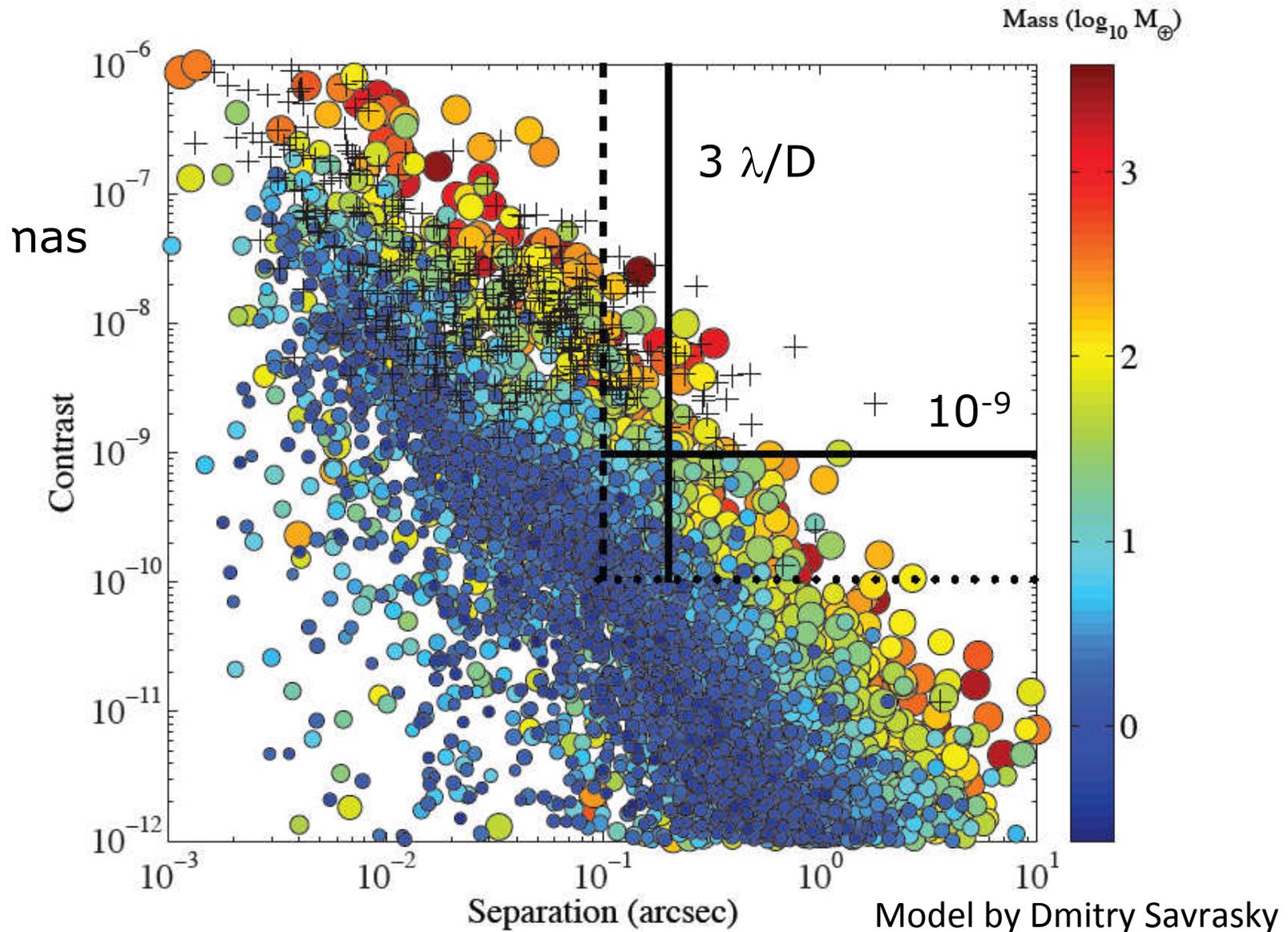


Fressin et al 2013; Kepler FGKM stars $P < 85$ days

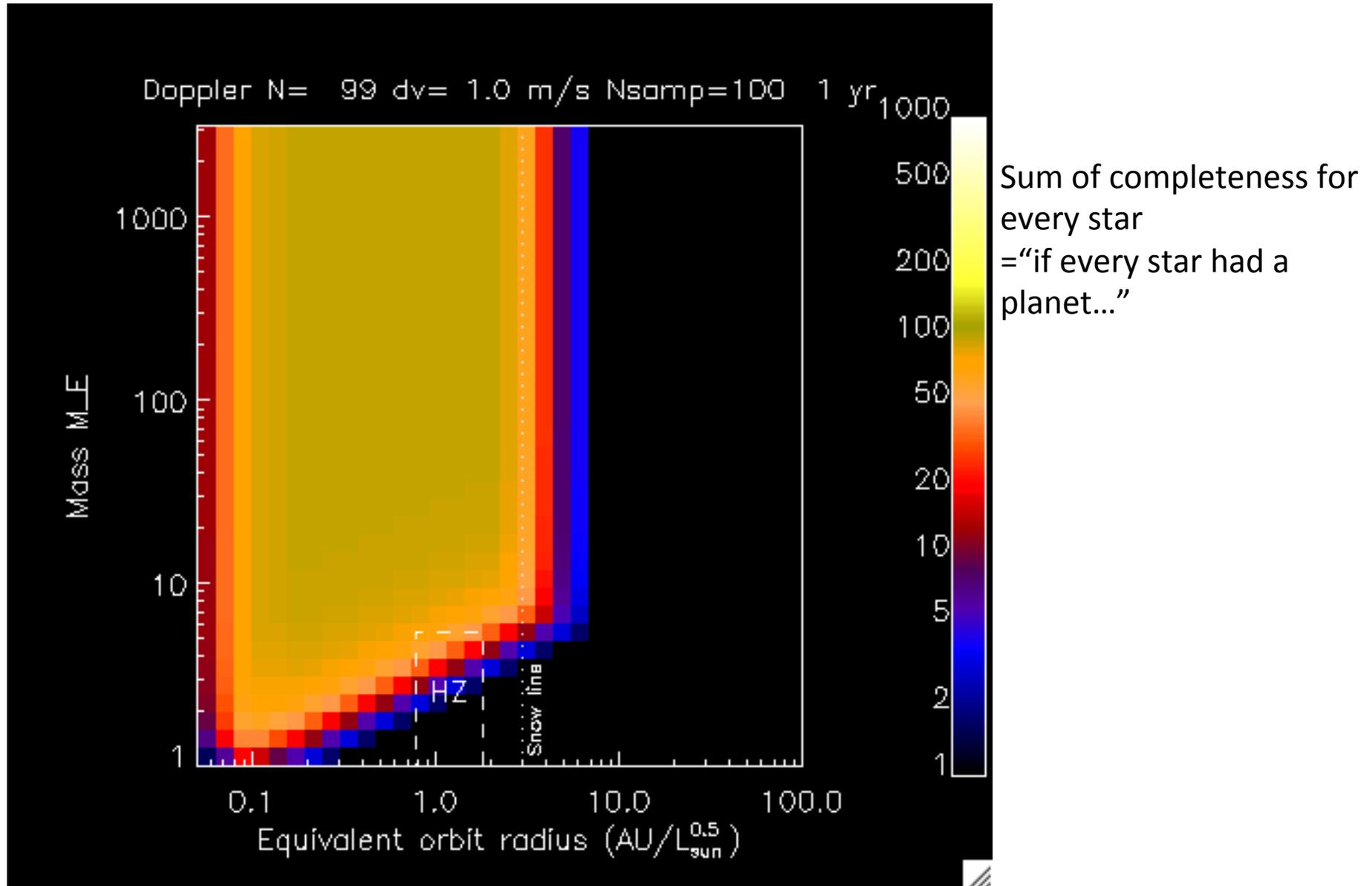
“Science Objectives” (option 1)

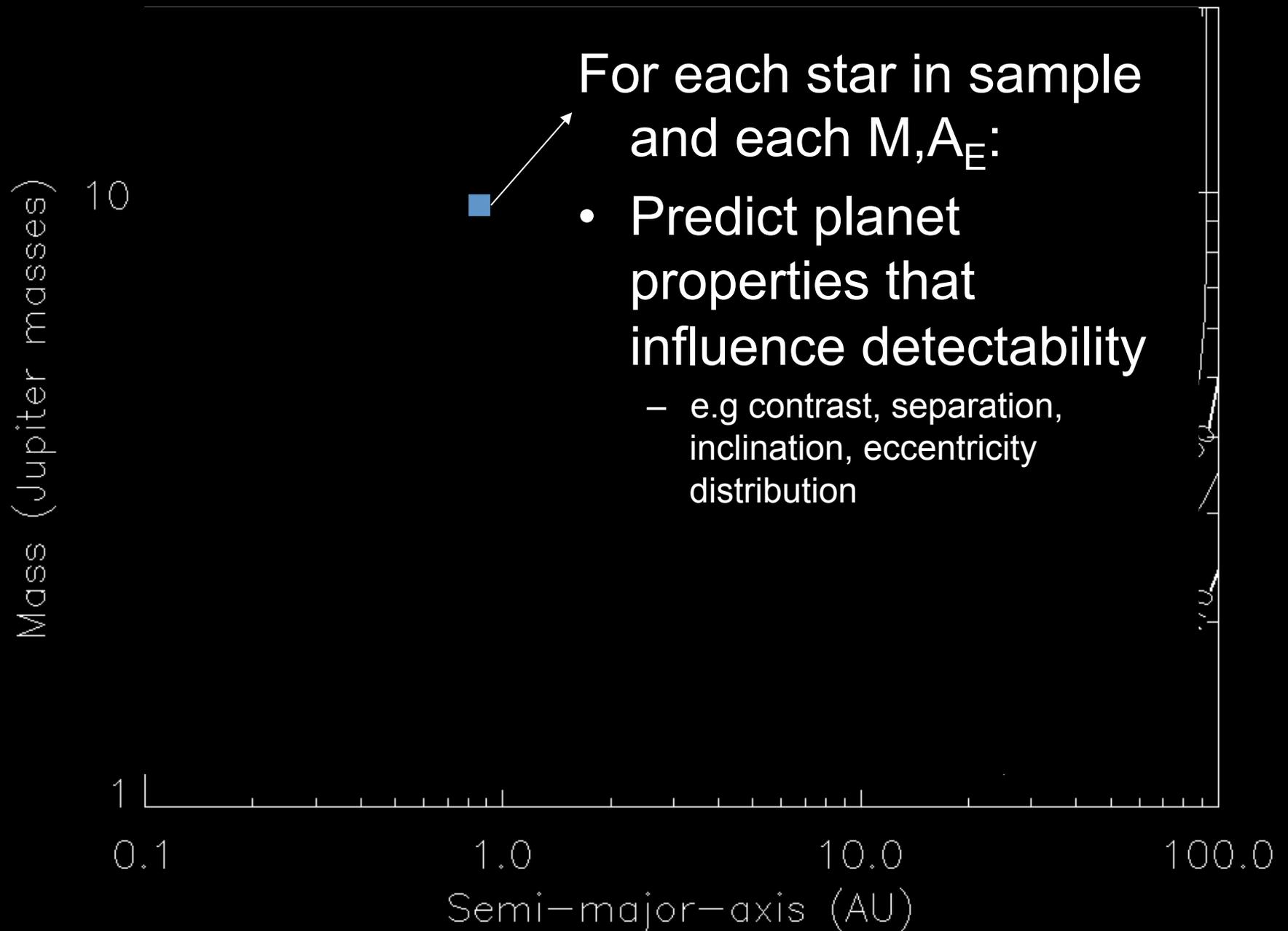
Requirement	Baseline	Threshold	Notes
Detect extrasolar planets (all radii)	16	0	This is relatively low importance
Detect extrasolar planets (<2.5 RE)	4	0	
Photometrically characterize (2 bands) extrasolar planets	10	2	Including known and self-luminous
Spectroscopically characterize (full coverage)	6	0	Including known and self-luminous

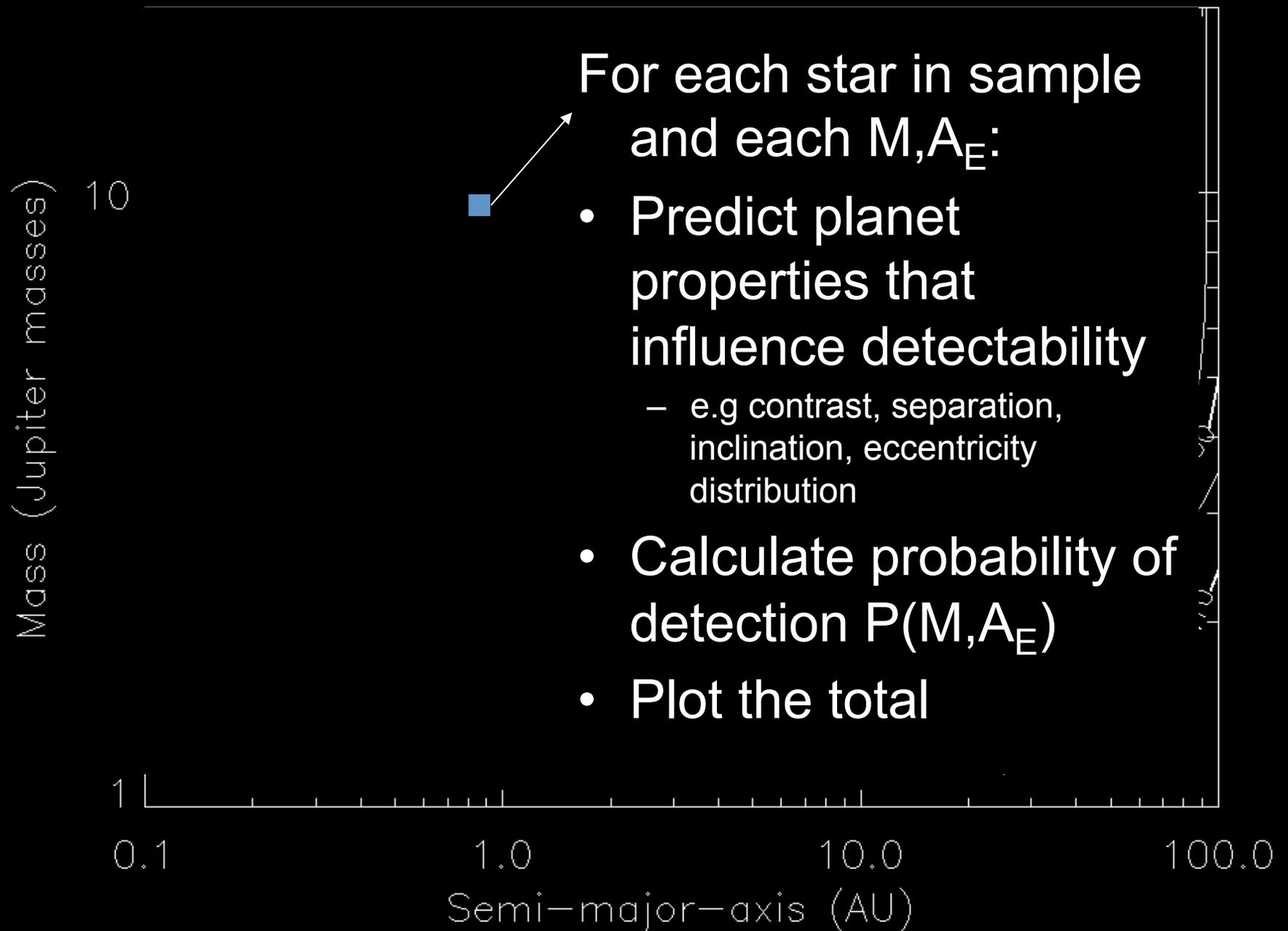
Exoplanet populations



Total detection completeness



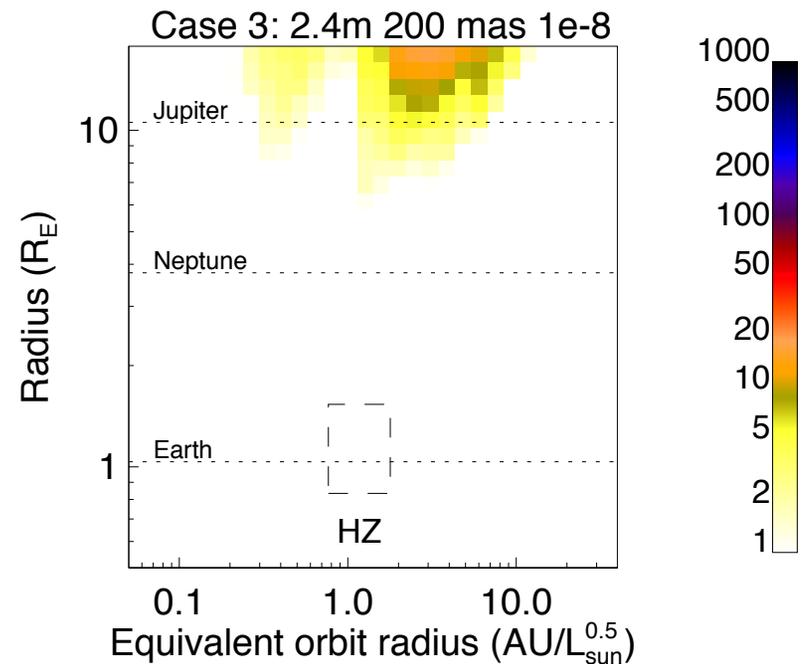
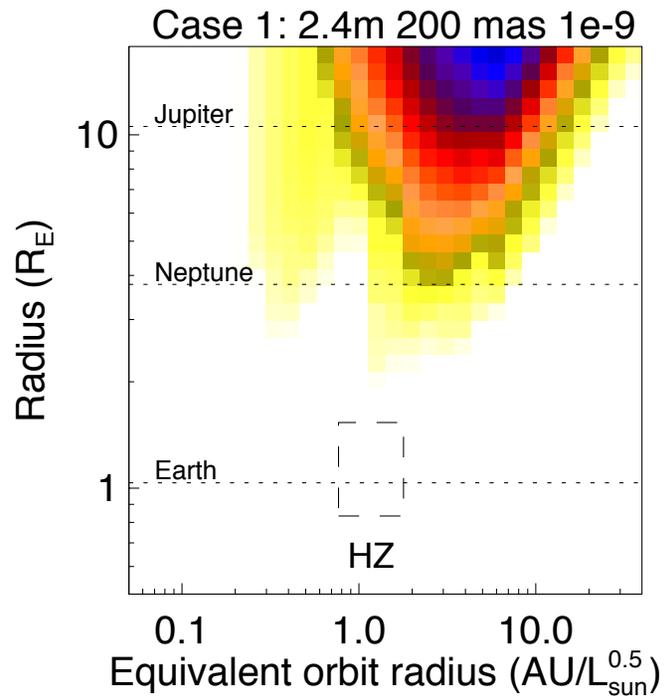




Alternative Science objectives or level 1 requirements

Requirement	Baseline	Threshold	Notes
Total detection completeness log(A) integral for 1 RJ	200	0	
Total detection completeness log(A) integral for 2 RE	10	0	
Total photometric characterization completeness (3 bands)	100		Including self-luminous???
Spectroscopically characterize (full coverage) known Doppler planets	4	0	Including known and self-luminous

AFTA coronagraph total completeness for various cases



Level 2? sensitivity requirements (imager)

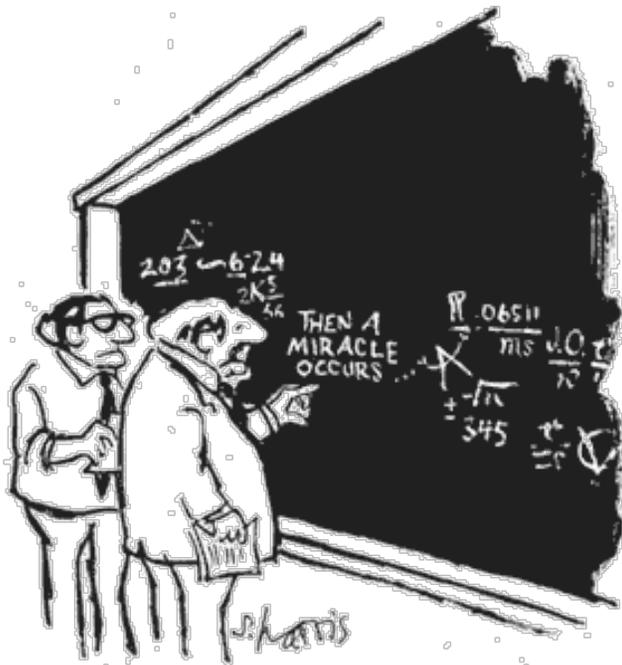
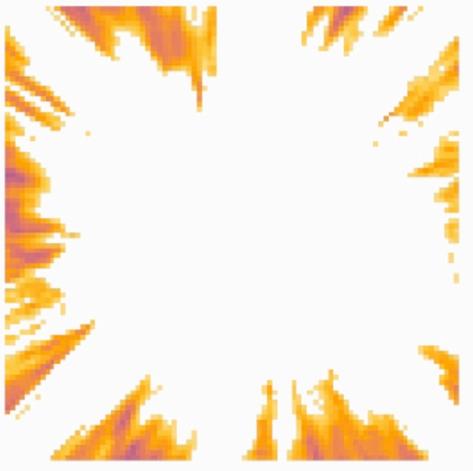
Requirement	Baseline	Threshold	Notes
Imager limiting magnitude 1 hour			With one zodi local and two zodi target
Detectable planet contrast imaging, 500 nm	1e-9	1e-8???	After all subtraction and post-processing
Effective IWA for above contrast, 500 nm	0.2?	0.3?	Spec wavelength
Effective fraction of FOV for above contrast at IWA	50%	33%	Considering only search, not PSF subtraction

- Consensus not to set contrast and IWA requirements but to allow a trade, either through FOM modeling or through an analytic scaling law
- We should still provide guidelines

Contrast requirements disconnect

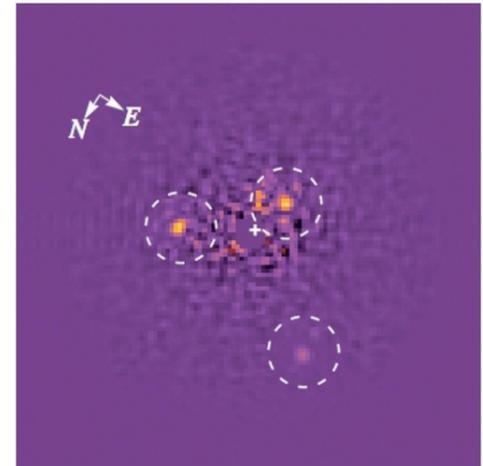
Also, will be very different for disks

Raw instrument contrast
Relatively easy to model



"I THINK YOU SHOULD BE MORE EXPLICIT HERE IN STEP TWO."

Final post-processed contrast
Easy to define as a scientific figure of merit



NICMOS images of HR8799 from Soummer et al

Contrast requirements options

1. Define only a final-detectable-planet contrast
 - Can be done scientifically
2. Assume final contrast scales with photon noise (e.g. '2 x photon noise')
3. Assume final contrast scales with raw contrast (e.g. 1/10 of raw contrast)
4. Assume an absolute floor (e.g. $1e-9$)
5. Carry out some simple analytical scenario modeling
6. Carry out detailed PSF subtraction simulations
7. Give up

Contrast prediction plan

- Will probably adopt some combination of 2 and 3
- Use mission simulations to evaluate whether 2, 3, or 4 actually produces a significant difference in yield
 - E.g. option 2 overpredicts contrast for very bright stars, but those are rare
 - Need to set floors on exposure time, etc.
- PSF repeatability is key but will not be modeled
 - However, aberration sensitivity helps determine this will be modeled and given some weight in downselect

Level 1 instrument requirements

Requirement	Baseline	Threshold	Notes
Imager Wavelength coverage	0.4-1.0 um	0.4-0.8 um	All requirements met over full band unless otherwise specified
Spectrograph resolution	70	15	Need to motivate this better
Imager Field of view	3x3"	2x2"	Disk science probably sets
Spectrograph wavelength coverage	0.6-1.0??	0.7.-0.9??	Iterate with modeling teams

Note: at this point these matter only in terms of their effects on coronagraph properties

Actions

- Generate / circulate working target list
- Iterate on the completeness requirements via email
- Explore analytic requirements
 - Use spectroscopy exposure times to constrain contrast/throughput/sharpness products
 - Use population statistics to constrain IWA/contrast products
- Carefully review assumptions for FOM modeling
 - Needs SDT consensus