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Coronagraph Science Studies by the WFIRST Preparatory Science Teams

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Community Astrophysics with WFIRST
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Basic CGI-related questions that need answers

- When & where should we look to find RV planets?
  - *What do the images tell us about orbital parameters?*
- How bright are RV planets in broad spectral bands?
  - *How do we interpret colors in terms of atmospheric properties?*
- What are the expected spectra of RV planets?
  - *How do we extract abundances and cloud properties from noisy spectra?*
- What background confusion is expected?
  - *How can we separate planet light from background objects?*
- What will disk images look like at CGI sensitivity & resolution?
  - *How do we interpret disk properties and the disk-planet relationships from images?*
- What is the expected yield from an optimal use of 1 year of CGI observing time?

  In what order should targets be observed, & for how long?

AFTA WFIRST Wide-Field Infrared Survey Telescope

WFIRST Preparatory Science (WPS): Coronagraph Instrument (CGI)

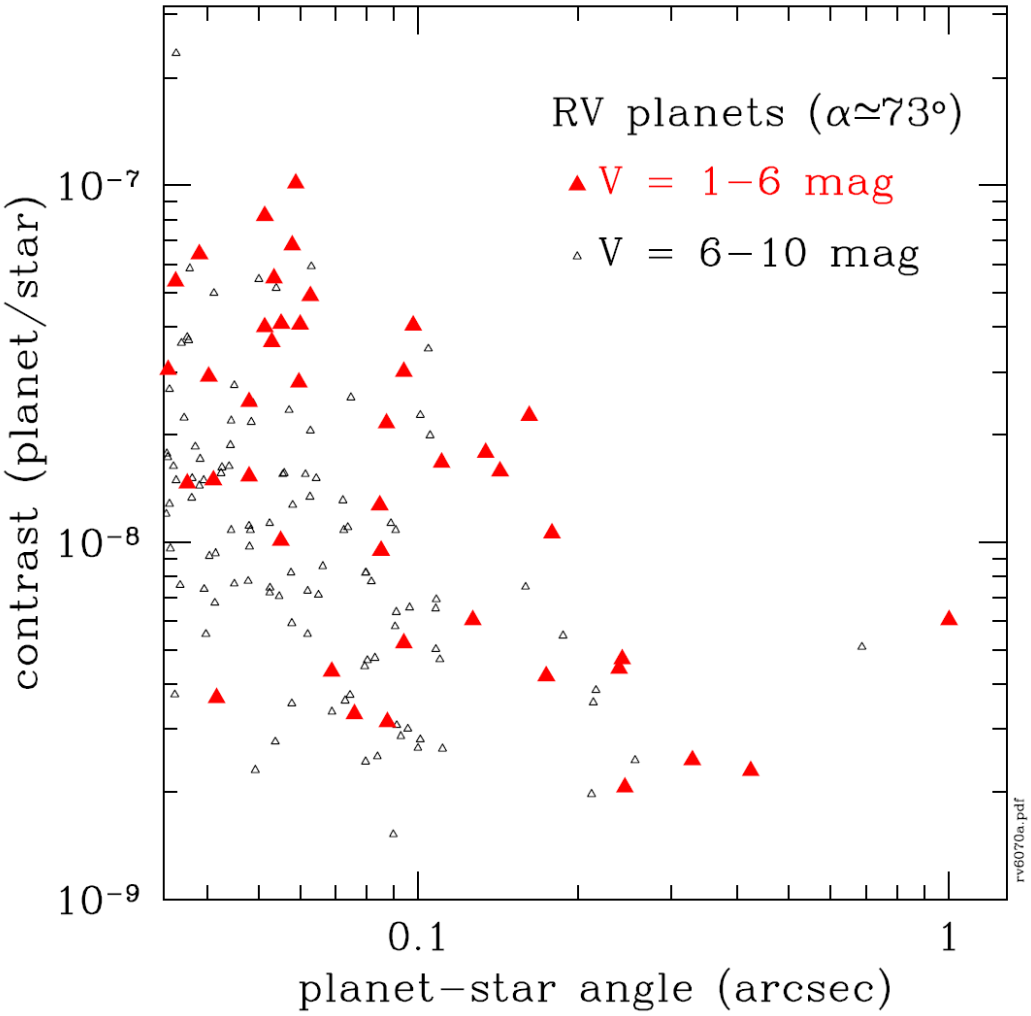
- 1-3 year studies of CGI-related science:

- Geoff Bryden: RV orbits
- Christine Chen: debris disk images
- Nikole Lewis: model atmospheres
- Dmitry Savransky: science yield via DRMs
- Maggie Turnbull: exoplanet colors

RV planet orbits

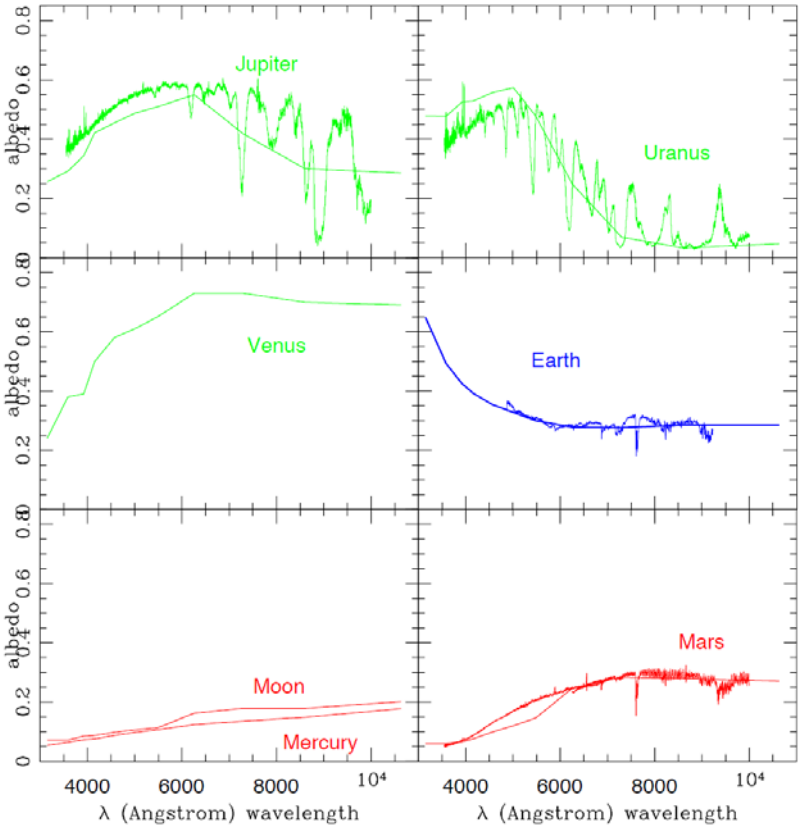
Contrast vs angular separation for known RV planets, assuming:

- e = 0
- i = 60 deg
- orbital anomaly = 70 deg
- albedo = 0.50
- Lambert phase fn.



G. Bryden will provide best observing times

Continuum shapes correlate with planet type

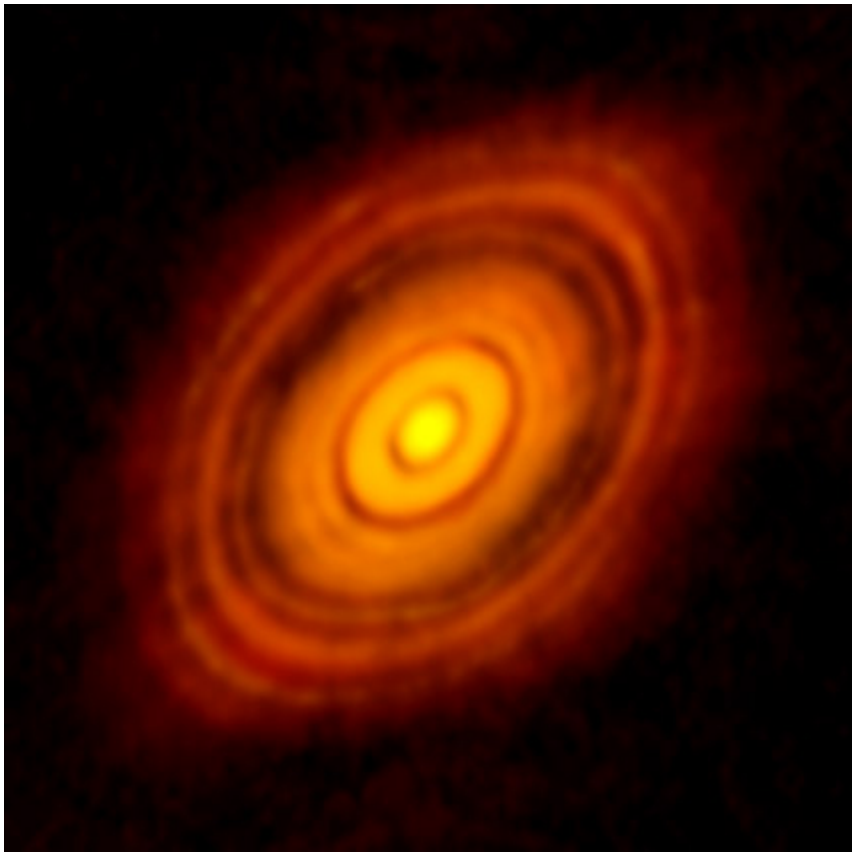


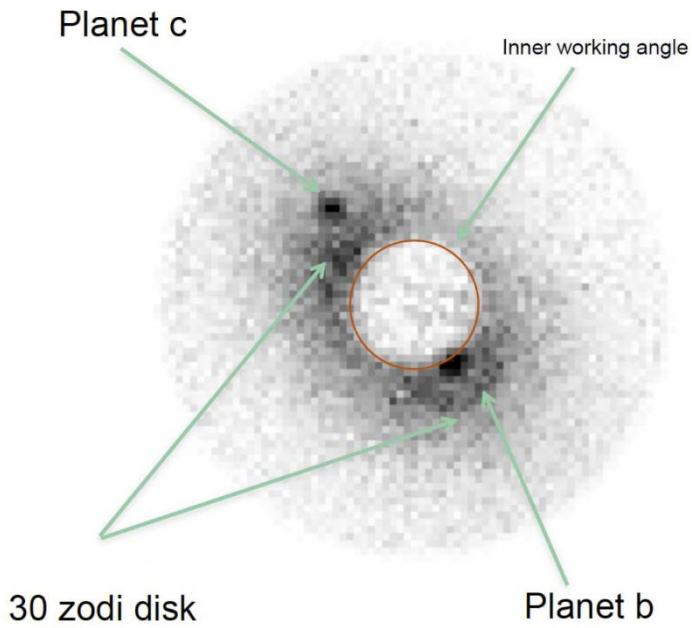
M. Turnbull will provide expected colors and backgrounds

Ref.: Sci. Frontiers in Res. on Extrasolar Planets, Deming & Seager eds, W. Traub, 2003

Ref.: http://imgsrc.hubblesite.org/hu/db/images/hs-2004-07-a-pdf.pdf

Dust disks, relation to planets?



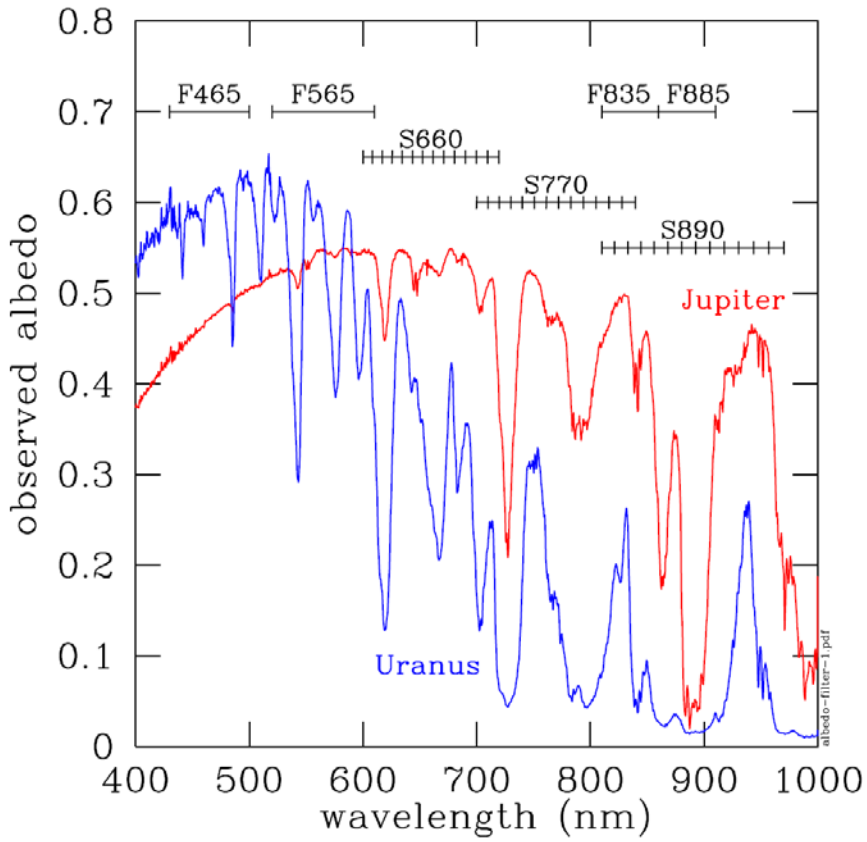


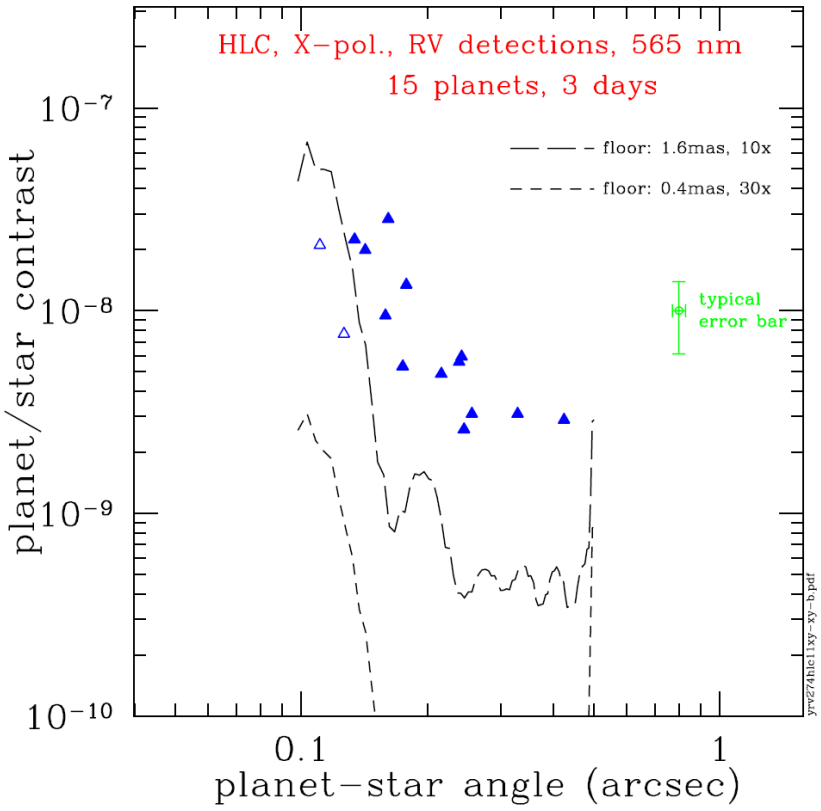
C. Chen will provide expected disk models & interpretations

Credit: ALMA (NRAO/ESO/NAOJ); C. Brogan, B. Saxton (NRAO/AUI/NSF)

47 Uma simulation: WFIRST-AFTA 2015 Report, Fig. 2-35 (T. Greene)

Jupiter/Uranus spectra, & CGI bands





N. Lewis will provide expected atmospheric models & interpretations

WFIRST coronagraph estimated yields

Output channel	Coron. name	Spectral resolution	Polarization	Primary science	Wavelength (nm)	Number of RV planets detectable	Requirement
imager	HLC	R = 10	X & Y pol., seperately	RV exoplanets & disks	blue: 465	18	>12
					green: 565	19	
					red: 835	10	
spectrometer (IFS)	SPC	R = 70	unpolarized	RV exoplanets	near-red: 670	10	>6
					mid-red: 770	8	
					far-red: 890	5	

1. Detections assume a best case of small pointing jitter (0.4 mas) and excellent post-processing speckle reduction factor (30x).

2. We expect that the actual case will be close to the best case, by using (a) feedback to control jitter, (b) advanced processing to reduce speckles, and (c) continued RV observations (WIYN) to discover more RV planets.

3. Most planets can be imaged in much less than 1 day; spectra will often take a few days. The totals are for a month-long campaign for imaging, and another month for spectroscopy.

4. **The baseline coronagraph is expected to exceed its requirements, with margin.**

D. Savransky will provide DRM models & science yields