



WFIRST-AFTA Coronagraph Science



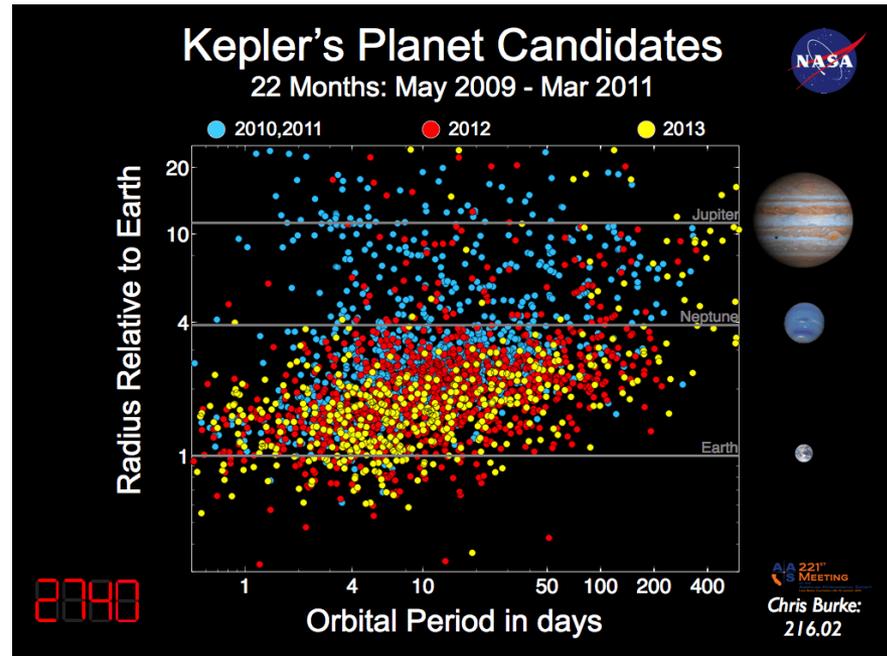
WFIRST-AFTA Coronagraph SDT Members

Draft April 2, 2014

- We now know planets are ubiquitous and varied
- Kepler has shown a large population of planets of diverse sizes and orbits

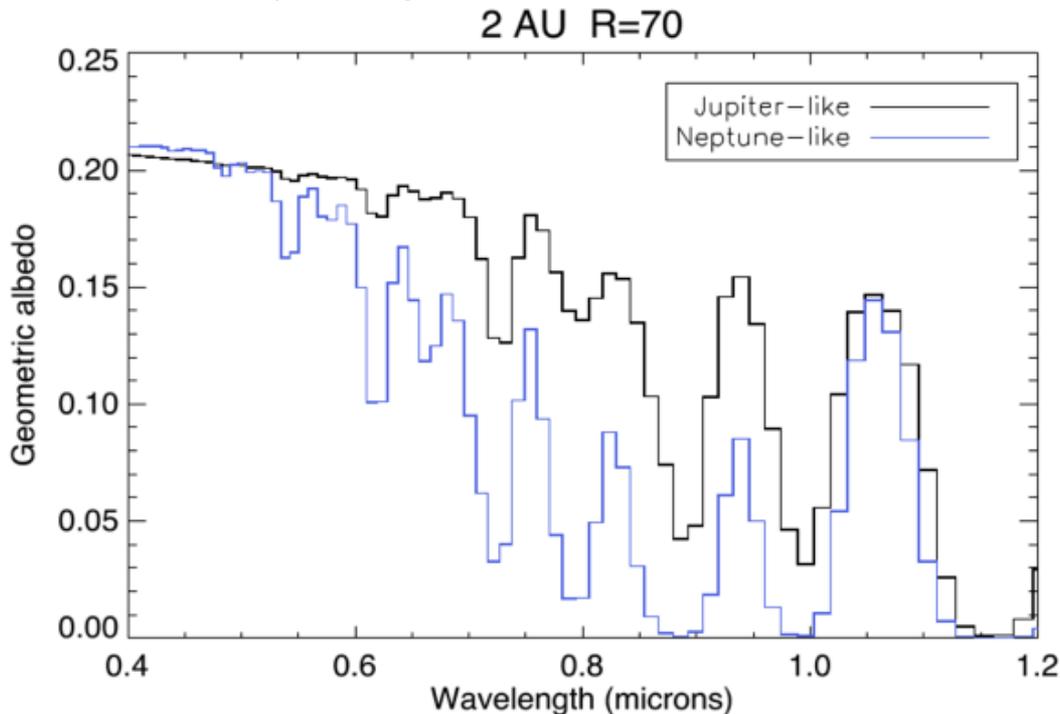
Rescale figure to show AFTA sensitive regime

Can generate a merged version with microlensing (with some consistency assumptions)



- WFIRST will characterize the planetary systems of nearby stars and prove the technology needed for finding Earths

- WFIRST-AFTA will be able to detect spectral features in giant planets and discriminate between planet types
 - First observations of reflected light from cool extrasolar planets
- Photometric characterization of 2 R_{earth} planets will probe cloud presence via albedo measurements
- Metallicity of giant planets illuminates formation history



WFIRST-AFTA data will:

- Detect molecular species
- Constrain abundances
- Reveal presence & height of clouds

May add super-earth cases to this figure, clean up colors

- A significant population of known RV planets will be characterizable spectroscopically or photometrically
- Discovery space for new planets extends down into 2RE range

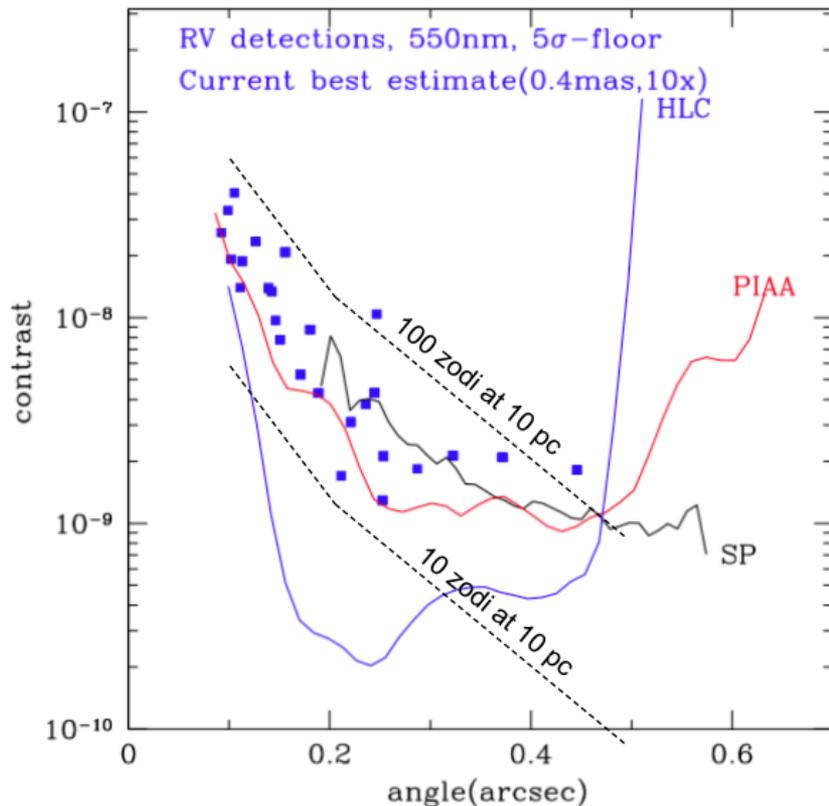
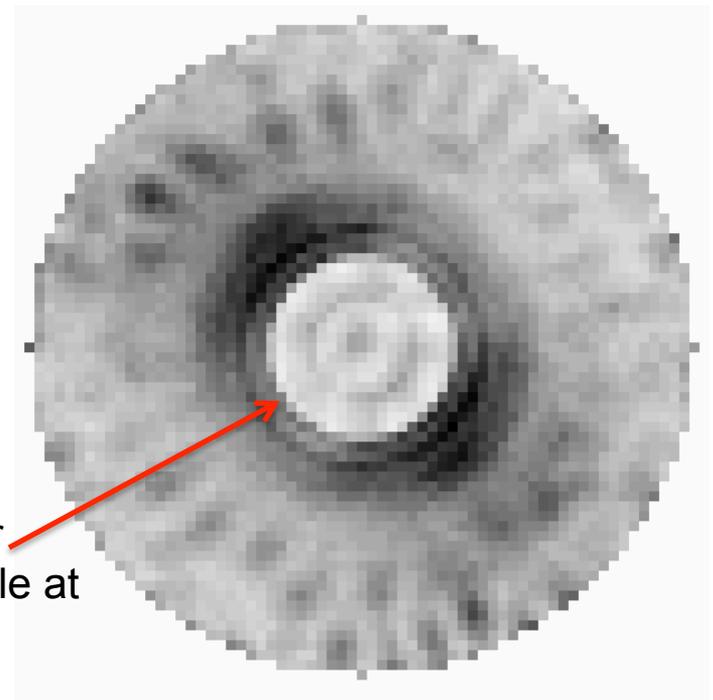


Figure cleanup: remove PIAA, SP;
 add photon noise to HLC case for
 fiducial observation; remove
 2xZodi line; add new discoveries
 from strawman blind-search sim

Coronagraph Science: Disks

- Circumstellar disks reveal the locations of planets and trace the history of collisions
- Few disks below 100x the solar system dust level (100 zodi) have been detected, and none have resolved images
- WFIRST-AFTA will detect disks to 10 zodi around nearby stars;
 - Important for planetary systems and for future Earth imaging missions
- WFIRST + LBT-I observations reveal total dust amounts and albedos → debris properties

1.1 AU inner working angle at $d = 8$ pc



Simulation of 20 zodi disk AFTA image (24 h at 8 pc)



Doppler measurements

- Knowing the masses of planets is critical for understanding the spectra from WFIRST-AFTA
- RV observations of nearby stars are currently largely incomplete
- WFIRST-AFTA would benefit greatly from having more known RV planets before launch:
 - A list of known planets will make WFIRST much more efficient for detection and characterization
- Increased RV observations over 5+ years are important precursor observations for WFIRST-AFTA
- RV investments are valuable for WFIRST!

Need a figure. Study by Howard et al being set up



Coronagraph tech development path



- WFIRST-AFTA Coronagraph is a necessary technological stepping stone for future Earth-imaging missions
- Performance gap between HST (and even JWST) and TPF is huge:
 - ~5 orders of magnitude needed
 - Even JWST does not have precision active wavefront control
- WFIRST-AFTA coronagraph is transferring the technology of extreme adaptive optics systems to space
 - Components and algorithms are optimized for space applications
- All aspects are applicable to an Earth imaging mission
 - Coronagraph, wavefront sensing & control, detectors, algorithms

Coronagraph tech development path

Mirror Diameter (m) for Inner Working Angle of $2 \lambda/D$ at 750 nm

