

Roman Coronagraph Instrument Overview and Observation Planning



Vanessa Bailey (she, her)
Jet Propulsion Laboratory, California Institute of Technology

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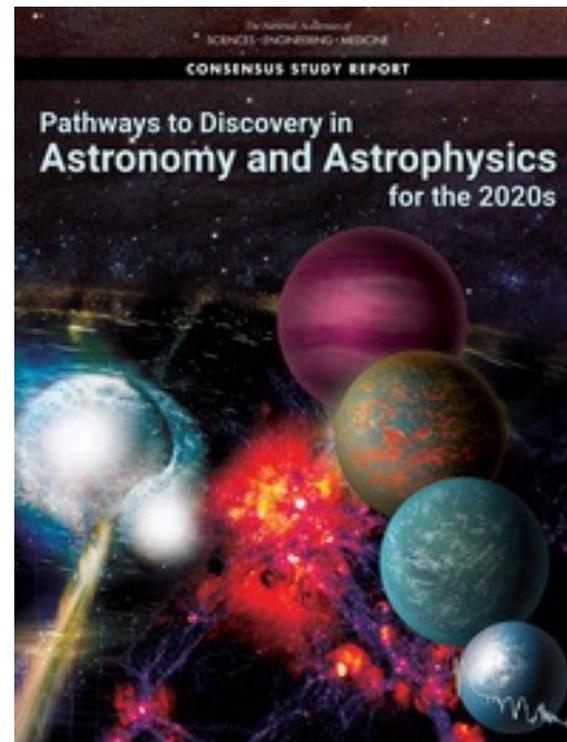
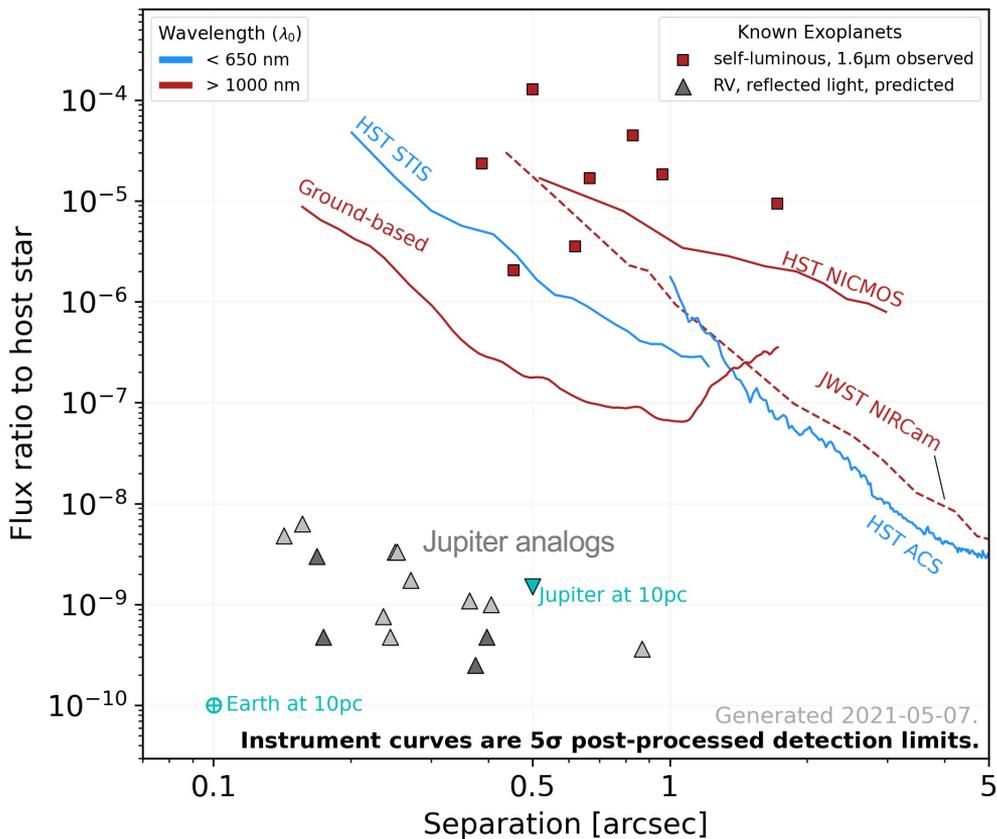
Thanks to Dominic Benford, Julie McEnery, Jeff Kruk, and Jason Rhodes for helpful feedback.



Outline

- Roman Coronagraph is a technology demonstrator for the future exo-Earth characterization mission
- In-flight “technology demonstration phase” aims to test limits of key technologies, *while observing scientifically interesting targets*
- Roman Coronagraph’s Community Participation Program will engage community in observation planning

Goal: Search for life on Earth analog planets with direct imaging and spectroscopy



NRC WFIRST / AFTA Study (2014)



Astro2010 recommendations. The 2014 NRC WFIRST/AFTA¹⁷ study concluded that the increase in aperture resulted in a powerful mission meeting all of the science goals of Astro2010, and that the addition of CGI was a positive step **if it focused on technology development and did not drive key mission requirements.** *In order to remain consistent with the balanced program recommended by*

NAS Exoplanet Strategy Report (2018)

Finding: Flying a capable coronagraph on WFIRST will provide significant risk reduction and technological advancement for future coronagraph missions. The greatest value compared to ground testing will come from observations and analysis of actual exoplanets, and in a flexible architecture that will allow testing of newly developed algorithms and methods.

Finding: The WFIRST-Coronagraph Instrument (CGI) at current capabilities will carry out important measurements of extrasolar zodiacal dust around nearby stars at greater sensitivity than any other current or near-term facility. ([see updates in Douglas+2022](#))

Recommendation: NASA should launch WFIRST to conduct its microlensing survey of distant planets and to demonstrate the technique of coronagraphic spectroscopy on exoplanet targets. (Chapter 4)

EOS1 panel report (2022)



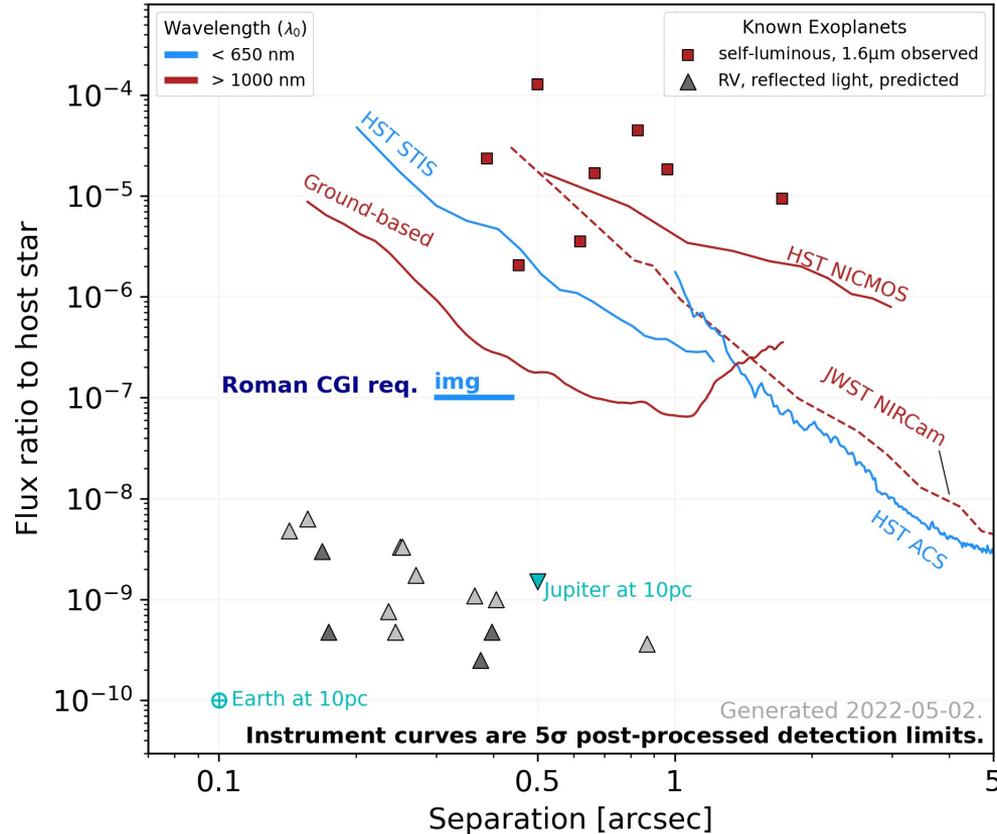
was added. The panel finds the mission compelling, and the CGI is a useful technology demonstration that will test deformable mirrors in the space environment and also closed-loop wavefront control. The

See [Mennesson+2020 for technology comparison to future mission needs. arxiv.org/abs/2008.05624](#)

young directly imaged planets because they have similar gravities and temperatures. Roman CGI will obtain optical wavelength thermal emission spectra of young companion objects as a complement to JWST and ground-based, longer wavelength observations, and perhaps reflected light spectra of a few cool giants. Both types of observations will inform the properties of giant planets, helping to place them in context with low-mass brown dwarfs. Additional surveys for substellar companions to stars that probe

prohibitively bright, being typically just a few times that of the zodiacal cloud; observations with the Roman CGI may also improve exozodiacal dust constraints. Terrestrial exoplanets now appear to be

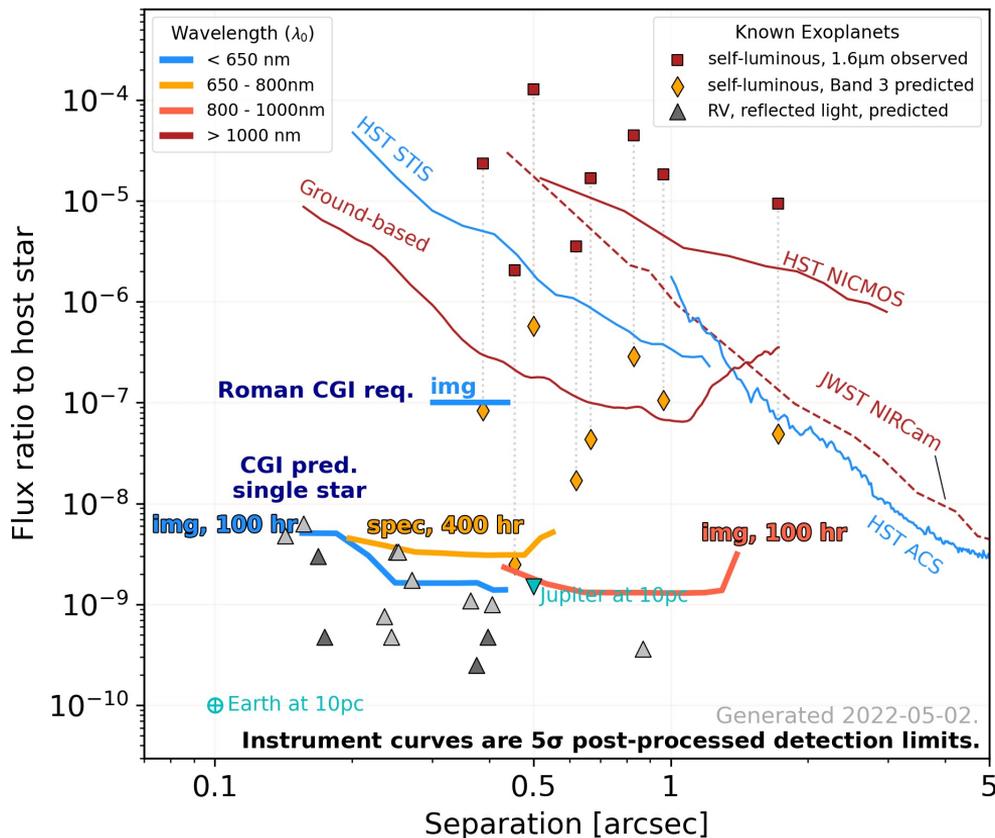
Roman Coronagraph is a tech demo for the Future Great Observatory



[github.com/nasavbailey/
DI-flux-ratio-plot/](https://github.com/nasavbailey/DI-flux-ratio-plot/)

Sergi Hildebrandt Rafels
Dmitri Savransky
Nikole Lewis
Natasha Batalha

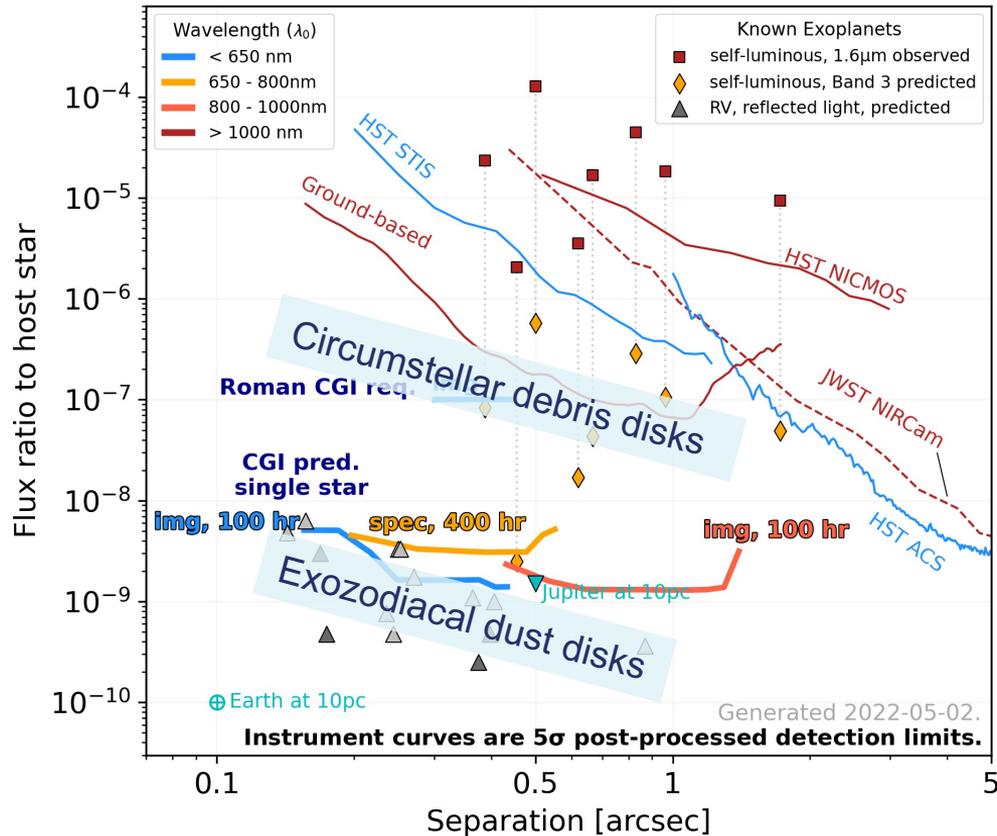
Coronagraph is expected to significantly advance key technologies & be capable of imaging exoplanets



Predicted 100-1000x improvement over SOTA

Many of the key technologies will already be comparable to future mission needs

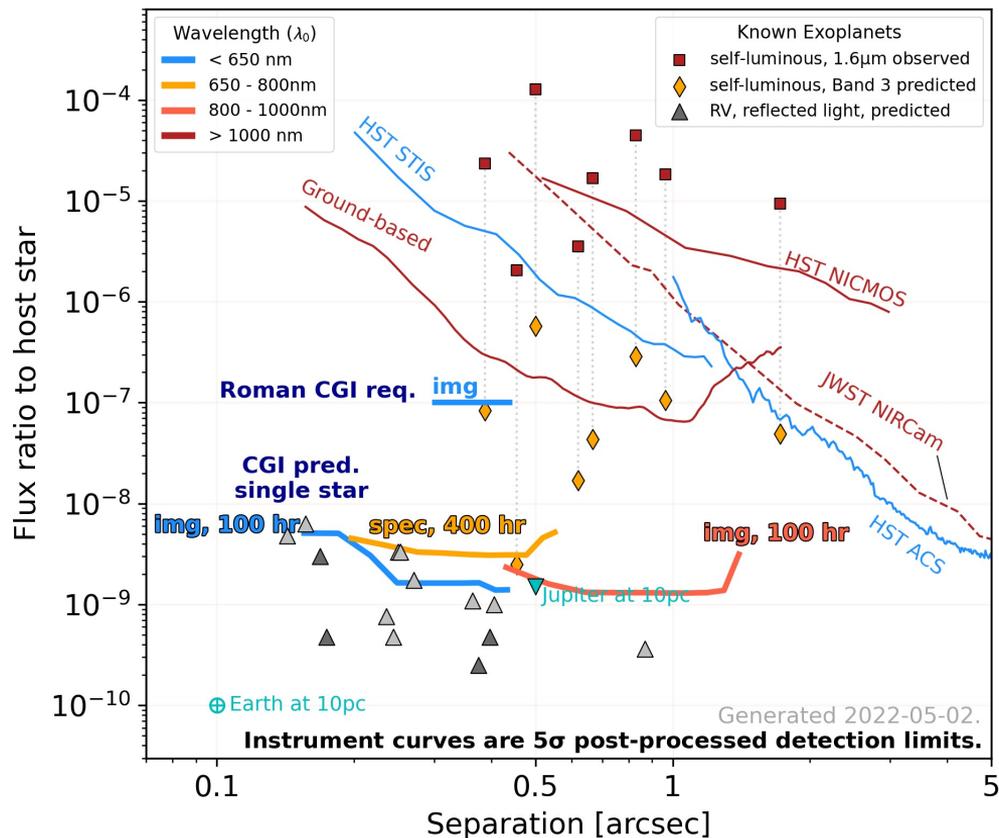
Coronagraph will be able to observe circumstellar disks at a range of surface densities



Coronagraph is not a snapshot survey instrument

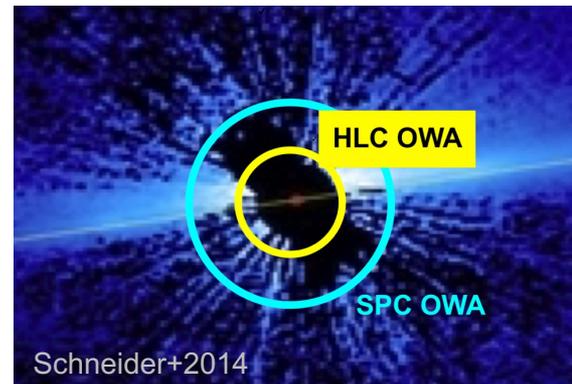
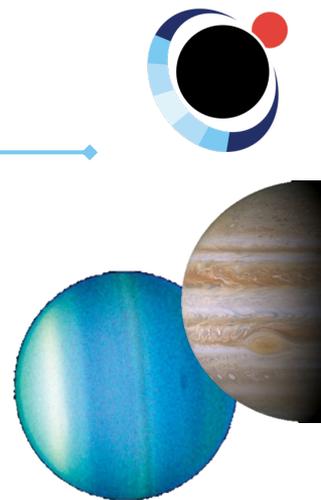
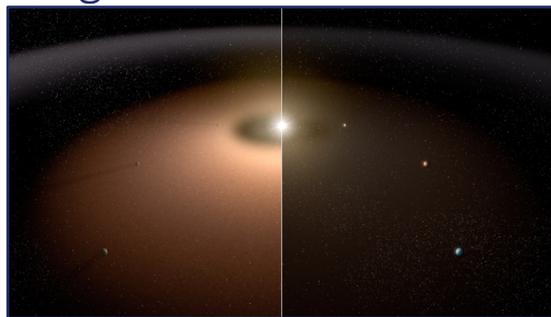


Out-performing Hubble requires hours of thermalization and image optimization (“dark hole digging”)



Capable of exciting exoplanetary system science

- Characterize known, self-luminous planets at visible wavelengths
 - (eg: Lacy & Burrows 2020)
- Potential for first images and spectrum of true Jupiter analog
 - (eg: Batalha+2018, Saxena+2021)
- Low surface brightness disks, improved morphology
 - (eg: Mennesson+2018)
- Potential for first visible light images of exozodi
 - (Douglas+2022)



Coronagraph “Technology Demonstration Phase”



- Baseline: 2200hr (90 days) during first 18mo of Mission
- Top priority: achieve L1 Technology Requirement
 - Flux ratio of at least 10^{-7} on a $V < 5$ star in Band 1
- Then, push performance limits to learn
 - Maximize long-term value to Future Great Observatory
- Use scientifically-interesting targets whenever possible
 - No GO program; will solicit community input on target selection

Community Participation Program (CPP) serves as conduit between Project and broader community



D.14 NANCY GRACE ROMAN SPACE TELESCOPE RESEARCH AND SUPPORT PARTICIPATION OPPORTUNITIES - DRAFT FOR COMMUNITY COMMENT

- A. Selecting suitable observing and calibration targets for the technology demonstration phase;
- B. Conducting precursor observations of high priority targets;
- C. Planning observations for the technology demonstration phase;

...

- J. Engaging the astronomical community to ensure that technology demonstration phase observations have long-term value to both the technology and science communities; and

Coronagraph Instrument during its technology demonstration phase; one example of community engagement could be soliciting community input on target selection. As a



Summary

- The best way to pave the way for future missions is to go beyond requirements and observe challenging targets
- In the baseline Technology Demonstration Phase
 - Expect 100-1000x improvement in contrast in visible wavelengths ($< 0.9 \mu\text{m}$)
 - Could take first reflected-light image of an exoplanet & exozodi
 - New parameter space in circumstellar disks & self-luminous young planets
- Operation beyond Tech Demo Phase is not in present baseline (not currently funded)
 - Continued operation is a decision best deferred until on-orbit performance and potential for scientific impact is established. NASA expects to use the Senior Review process.
- Community Participation Program (CPP): draft solicitation is now open for comment
 - Selected CPP team will be tasked with engaging the broader community in target selection