Technology and science advancing observations with the Roman Coronagraph informed by ground-based high-contrast imaging

Mona El Morsy [1], Thayne Currie[1,2], Brianna Lacy, Danielle Bovie[1]

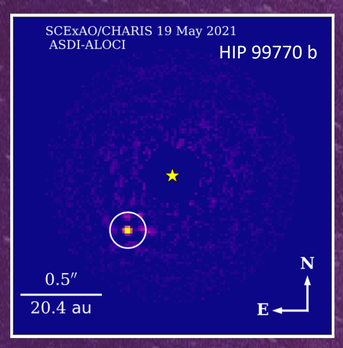
1-Department of Physics and Astronomy, University of Texas-San Antonio, San Antonio, TX, USA, 2-Subaru Telescope, National Astronomical Observatory of Japan, 650 North A'ohoku Place, Hilo, HI 96720, USA, 3-NASA-Ames Research Center, Moffett Field, CA

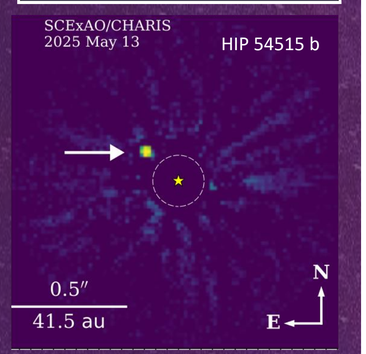
Overview

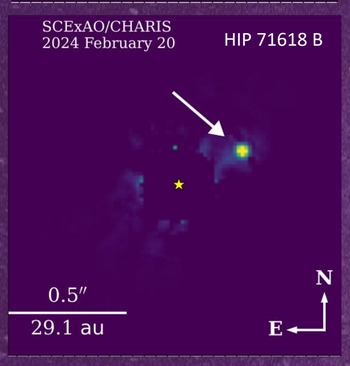
The Roman Coronagraph technology demonstration focuses on achieving <10^{-7} contrasts within the instrument's dark hole and our ability to detect and characterize properties of faint companions around bright stars.

In this presentation, we describe results from a study of potential Roman Coronagraph technology demonstration phase observations focused on these goals, informed by the ongoing OASIS survey at the Subaru Telescope and precursor survey work. OASIS provides at least three compelling targets for the technology demonstration phase with imaged companions – the HIP 71618 B brown dwarf and superjovian planets HIP 54515 b and HIP 99770 b. HIP 71618 is well suited for demonstrating the Coronagraph's core performance requirement while all three targets are well suited for spectroscopic mode observations. Each target can be paired with a PSF reference star vetted for companions.

Sample







HIP 99770 b [1] – Superjovian Planet

-~15 M_{Jup}, a ~ 17 au, e ~ 0.3
-orbits a ~115-200 Myr old V=4.9 mid A star
-cloudy L8 dwarf; metal-rich atmosphere; formed by core accretion [4]

HIP 54515 b [2] – Superjovian Planet

-~17 M_{Jup}, a ~ 24.5 au, e ~ 0.4
-orbits a ~115-200 Myr old V = 6.8 early A star
-M/L transition object

HIP 71618 B [3] – Brown Dwarf

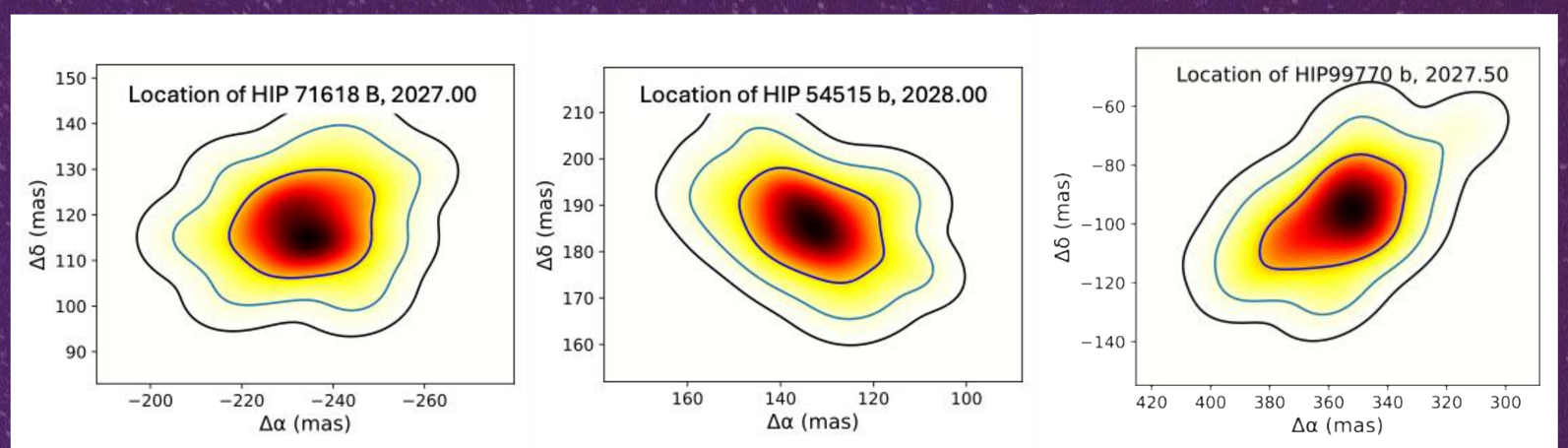
-~60 M_{Jup}, a ~ 11 au, high eccentricity
-orbits a ~115-200 Myr old V = 5.4 early A star
-mid M dwarf

Analysis Methods

- **Joint direct imaging and astrometric modeling with orvara [4] to constrain companion dynamical masses and orbits, including positions during the Roman Coronagraph Technology Demonstration Phase**
- **Atmospheric modeling with the Lacy/Burrows models to predict contrast in the Roman Coronagraph passbands [5]**
- **Vetting of candidate PSF reference stars that could be paired with targets**
- **Schedulability of target+PSF reference star sequences using Roman Community Participation Program software; Exposure Time Calculations**

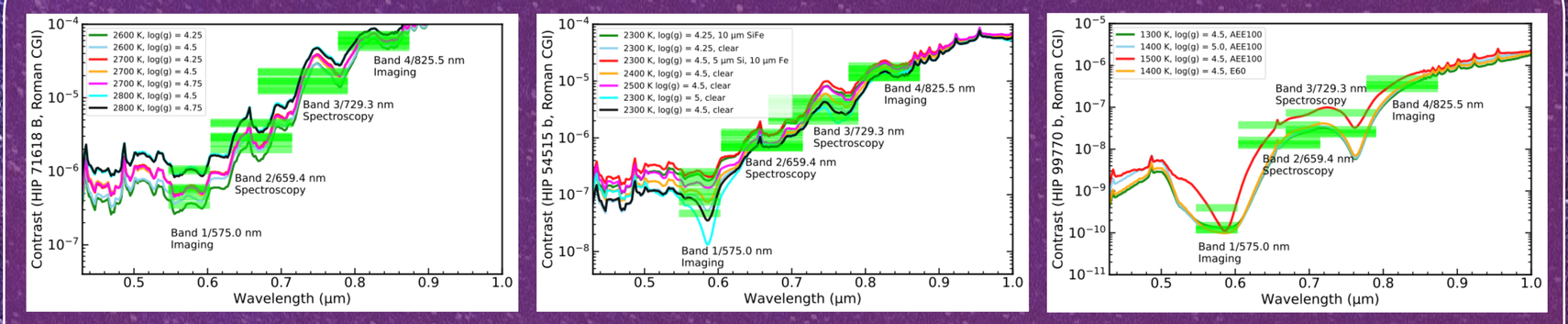
Results

Angular Separation During the Roman Technology Demonstration



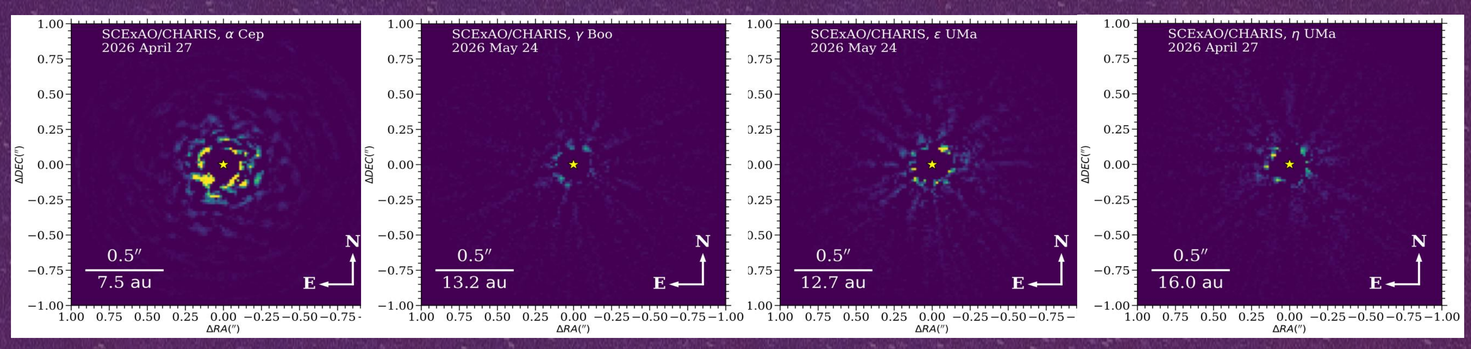
Observability of HIP 71618 B, HIP 54515 b, and HIP 99770 b during the Roman Coronagraph Technology Demonstration Phase. The contours represent 1, 2, and 3-sigma contours drawn from the posterior distribution of orbits derived from orvara. All three companions lie within the deep-contrast dark hole region for Roman's Hybrid Lyot Coronagraph at 575 nm (Band 1) for imaging as well as in Bands 2 and 3 for the Spectroscopic mode. While HIP 71618 B's nearly edge-on orbit means it will eventually (>3 years) be unobservable by Roman, the two planets could easily be accessible during a Science campaign (if approved).

Predicted Contrast in the Roman Coronagraph Passbands



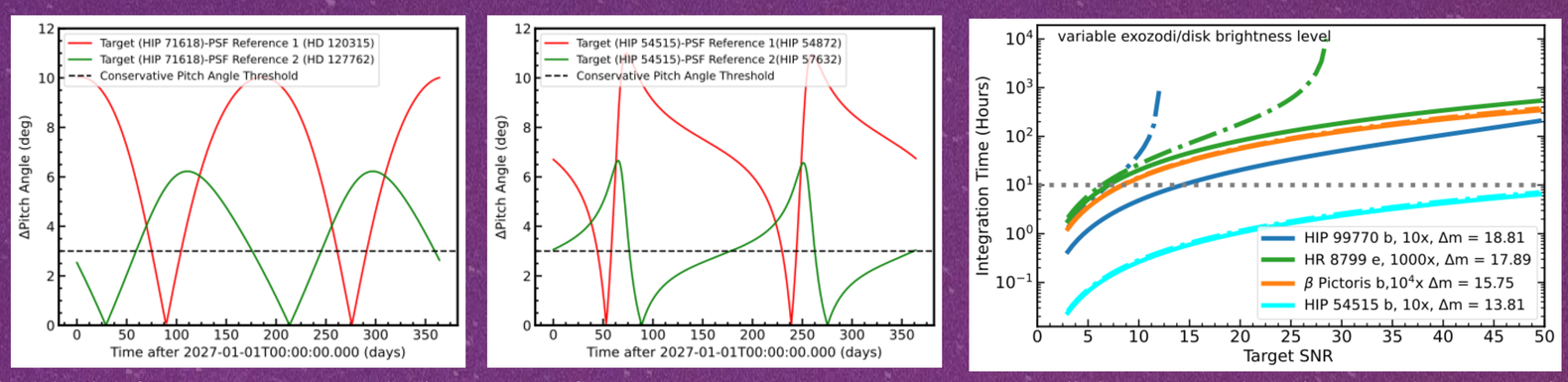
Predicted Contrasts of HIP 71618 B, HIP 54515 b, and HIP 99770 b in the Roman Coronagraph bandpasses drawn from the Lacy/Burrows atmosphere models. HIP 71618 B's predicted 575 nm contrast lies just slightly above the TTR5 benchmark of 10^{-7}, while HIP 54515 b may be slightly fainter. HIP 99770 b is likely undetectable at 575 nm. In Band 3, the companions have contrasts of ~ 5x10^{-8} to 10^{-5} and thus are suitable for spectroscopic mode observations.

PSF Reference Star Vetting



Using SCExAO/CHARIS, we obtained high-contrast imaging data for candidate PSF Reference Stars that could potentially be paired with HIP 71618, HIP 54515, and HIP 99770 Roman Coronagraph observations. Three of the targets draw from the spreadsheet maintained by the Roman Community Participation Program (CPP), while one (gamma Boo) is a star missed by the CPP list. For most stars, we can rule out companions at contrasts of 10^{-5} at 0.25" and 10^{-6} at 0.5"; limits for alpha Cep (HIP 105199) are poorer due to low-wind effect. The lack of detected companions strengthens the case for using these stars as references during the Technology Demonstration Phase.

Roman Coronagraph Scheduling



Schedulability for Roman Coronagraph observations of HIP 71618, HIP 54515, and HIP 99770. All three targets have large windows over which observations can be paired with PSF reference stars with a delta pitch angle <3 degrees. HIP 99770 b is the most technically challenging detection, but it should have a predicted SNR of ~ 10-15 in ~10 hours of integration time; HIP 54515 and HIP 71618 require significantly less observing time.

Acknowledgements

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Conclusions/Status of Proposed Observations

- **HIP 71618 is especially well suited for demonstrating TTR5**
- **All three targets suitable for Band 3 Spectroscopic Mode observations**
- **PSF reference stars that could be paired with all three targets so far show no evidence for companions that could make them unsuitable references**
- **As of 1 Feb 2026, HIP 71618 is targeted for early Technology Demonstration Phase observations in Band 1 for demonstrating TTR5 [6]**
- **Both HIP 71618 and HIP 54515 are planned for Band 3 spectroscopic Mode observations [6]**

References

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