CorGI-REx: Reference Star Vetting for the Roman Coronagraph Instrument with High-Contrast Imaging from VLT/SPHERE

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ROMAN CORONAGRAPH

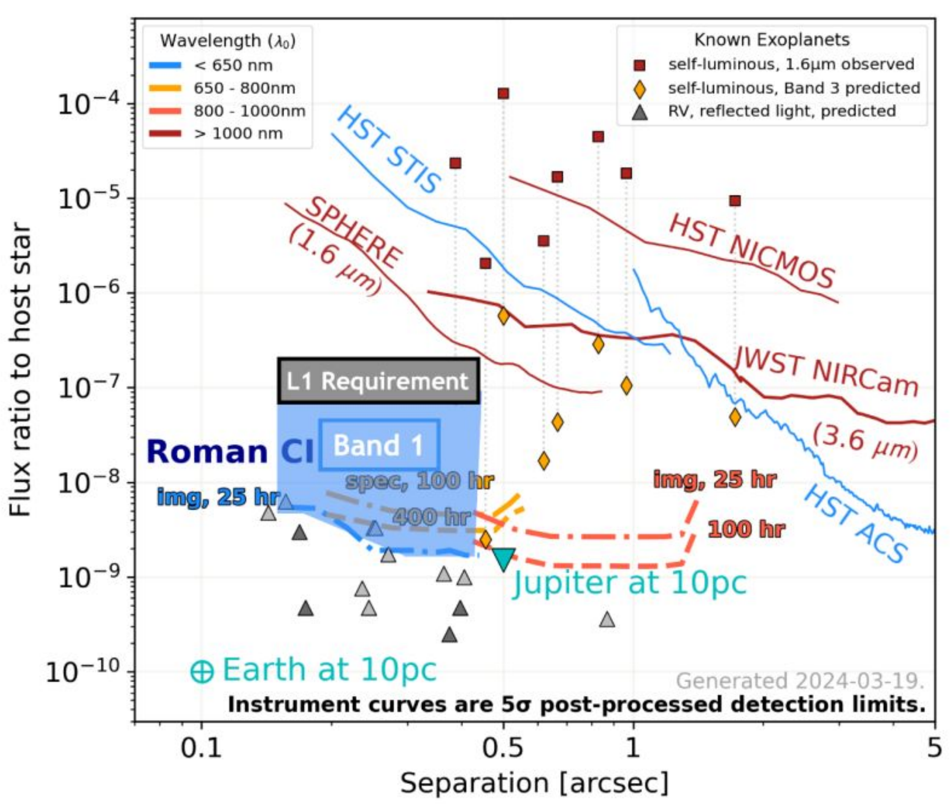
NANCY GRACE ROMAN SPACE TELESCOPE

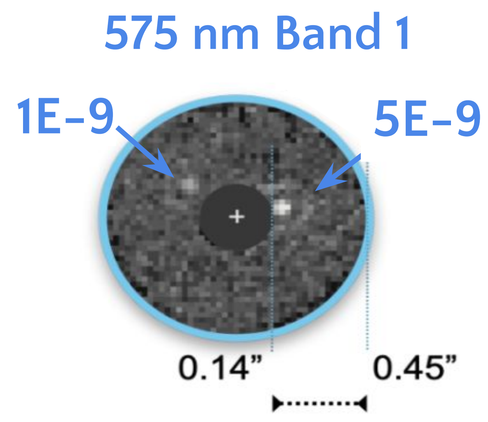
1. Introduction

The Nancy Grace Roman Space Telescope (launching in late 2026) will carry the first space-based coronagraph capable of directly imaging mature, cold exoplanets in reflected light. This will be a major step toward imaging Earth-like worlds and paving the way for Habitable Worlds Observatory (HWO) and the Extremely Large Telescope (ELT).

To reach the extreme contrast needed to detect faint planets, the Roman Coronagraph will combine active wavefront sensing and control, high-performance coronagraphs, and ultra-low-noise photon-counting detectors. Laboratory test have achieved contrasts of 1E-7:1E-9 (the latter comparable to the Sun–Jupiter brightness ratio at visible wavelengths).

During the first 18 months of the mission, 2200 hours will be dedicated to the Roman Coronagraph technology demonstration (Roman Coronagraph Primer, 2025).

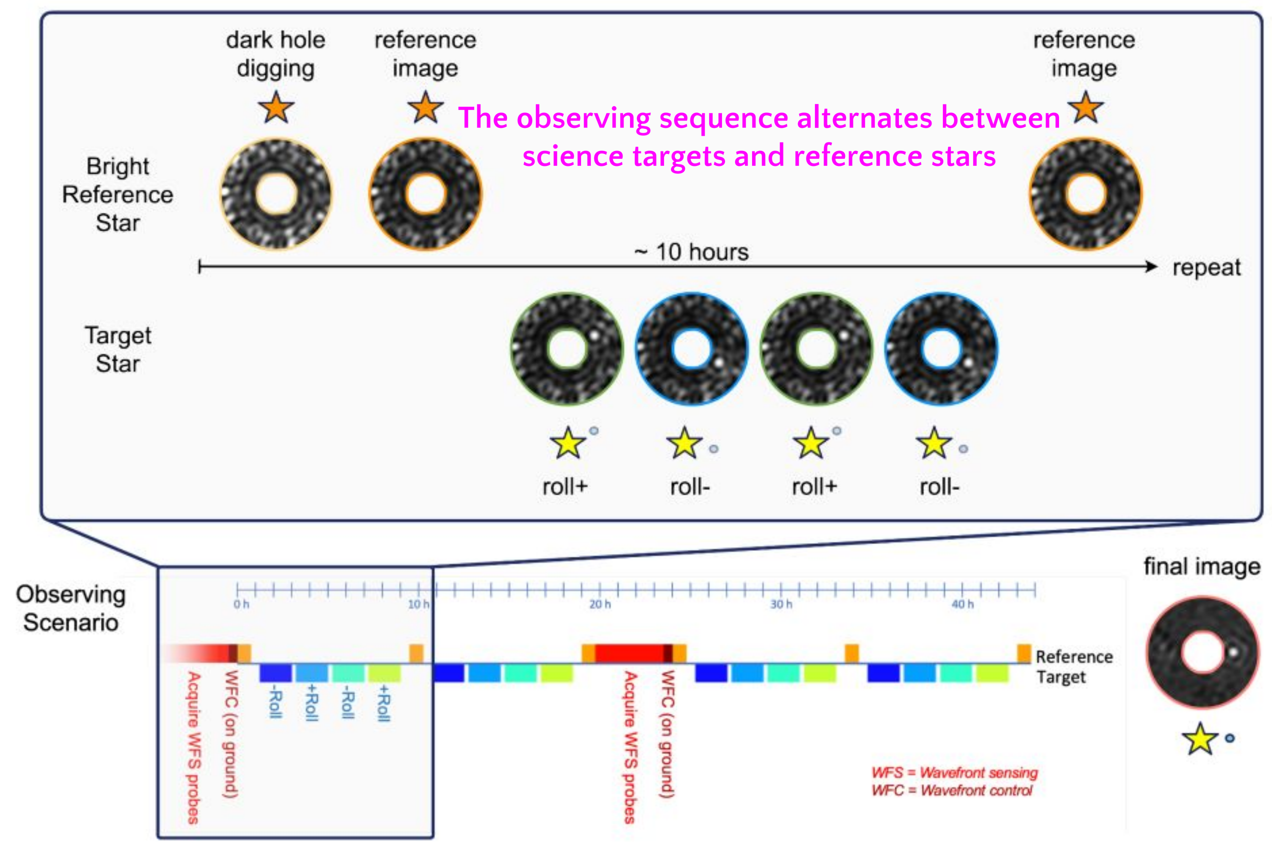




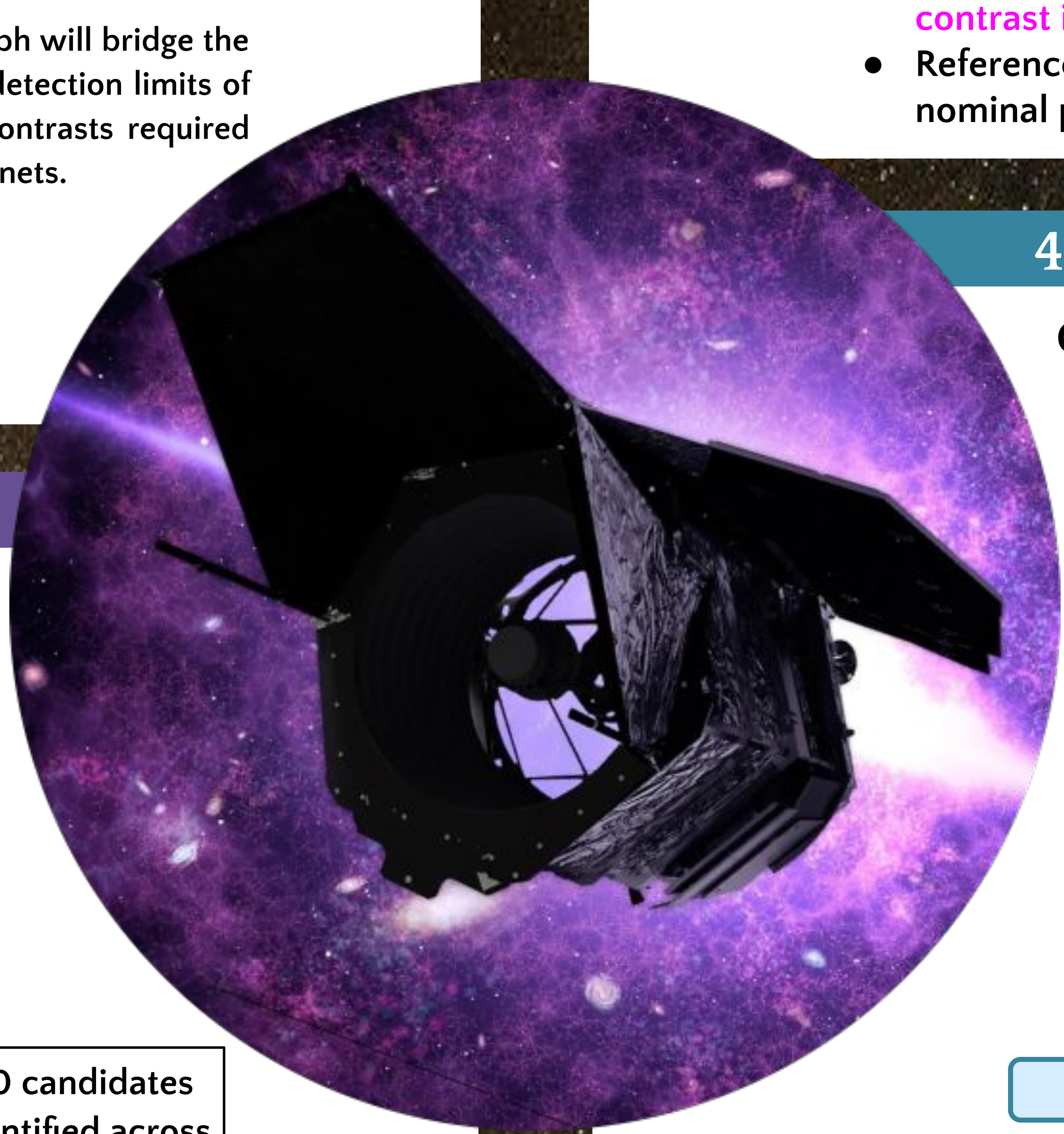
The Roman Coronagraph will bridge the gap between current detection limits of ~1E-6 and the 1E-10 contrasts required to image Earth-like planets.

2. Why do we need reference stars?

Achieving and maintaining high contrast requires active wavefront sensing and control, which depend on bright reference stars. However, not all science targets are sufficiently bright for this purpose.



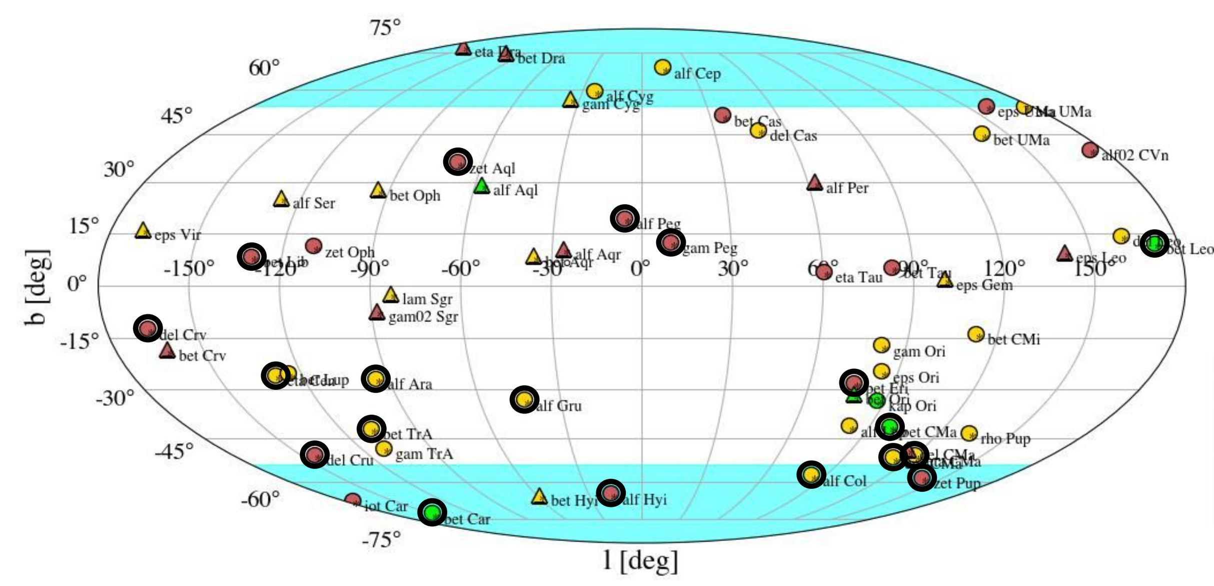
- Reference stars are used to maintain the *dark hole* region, reaching a ~1E-8 raw contrast in ~17 hours for the faintest reference stars (V=3).
- Reference stars enable Reference Differential Imaging (RDI), which will be the nominal processing of the Roman Coronagraph data.



3. Reference Star Vetting

Reference stars Criteria:

1. Bright (V < 3) for efficient overhead times.
2. Resolved small angular diameter (< 2 mas) to prevent extra jitter noise.
3. "Cannot" have any companions (bound and/or background), as they might degrade contrast through flux leakage.
4. **Δpitch angle (angle between science and reference star) ≤ 5°.**



40 candidates identified across the sky

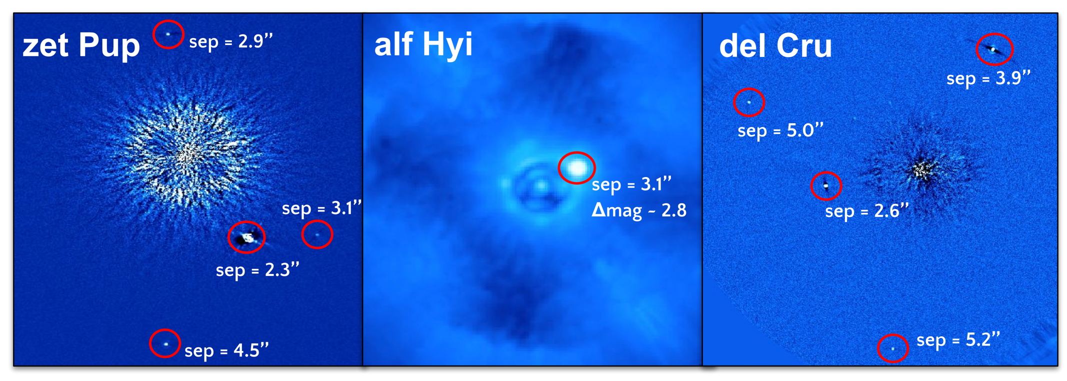
The CoronaGraph Instrument Reference stars for Exoplanets (CorGI-REx, Hom+2026) campaign identifies and vets the reference star candidates for the Roman Coronagraph before science operations begin. The vetting process combines literature reviews and catalogue queries of stellar properties and multiplicity, archival high-contrast imaging and interferometric data analyses, and new ground-based observations from telescopes around the world.

Southern hemisphere vetting with SPHERE to probe for bound companions or background objects that could degrade the performance of the High Order Wavefront Sensing and Control.

Observations:
- 31 targets observable from the southern hemisphere
- 8 targets with archival data from SPHERE (Dual-band imaging in H2H3 or K1K2 bands + IFS)
- 11/16 targets with precursor observations (November 2024 - Ongoing)
  - Dual-band IRDIS H2H3 and IFS Y observations:
    - Snapshot observations: 30 minutes exposure time
    - Deep imaging observations: 1.5 hours
- Data processed using NoADI unsharp, Angular Differential Imaging (Marois+2006) , and KLIP (Soummer+2012) with pyKLIP (Wang+2015)

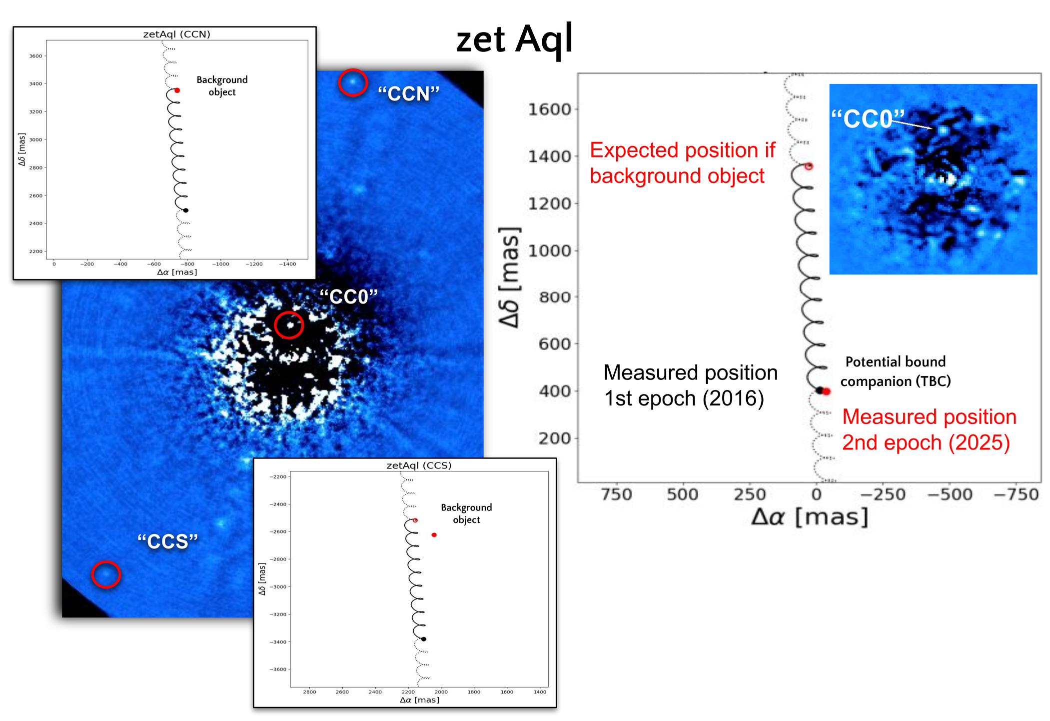
4. Results of southern vetting with SPHERE

Companions detected:
- 31 previously unreported companion candidates identified around 10 stars.
  - 3 companion candidates within the Band 1 dark hole region.
  - 1 bright companion at ~0.825" (within the Band 4 dark hole region)
  - 27 companion candidates with separations > 2"

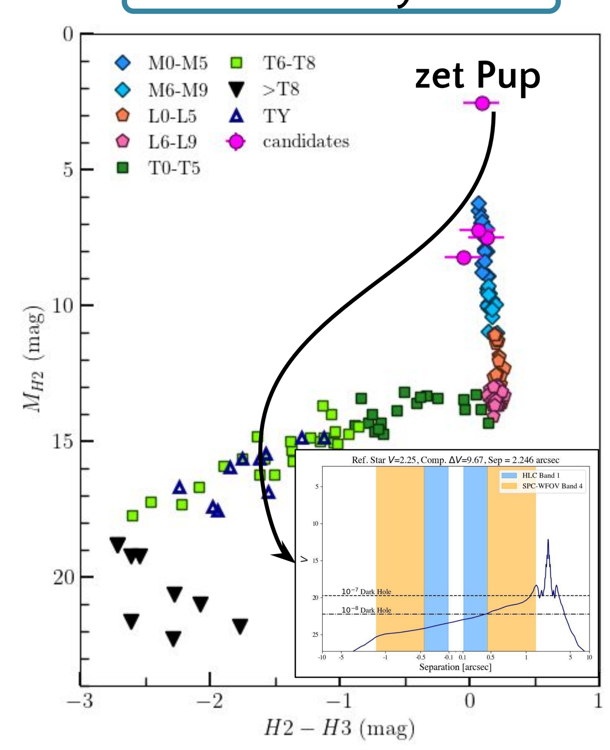


Bound companion or background object?

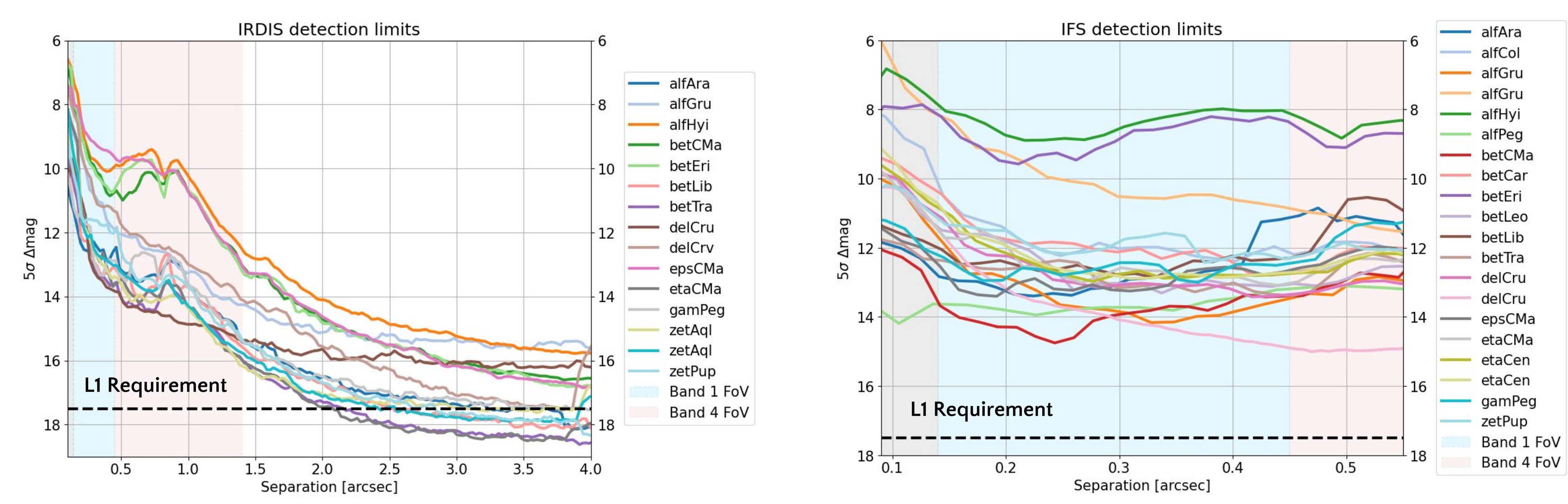
Common Proper Motion Analysis



CMD Analysis



Detection Limits



References and Acknowledgements

- **Hom+2025,** "*CoronaGraph Instrument Reference Stars for Exoplanets (CorGI-REx). I. Preliminary Vetting and Implications for the Roman Coronagraph and Habitable Worlds Observatory*"
- **Wang+2015,** *"pyKLIP: PSF Subtraction for Exoplanets and Disks"*
- **Soummer+2012,** *"Detection and Characterization of Exoplanets and Disks Using Projections on Karhunen-Loève Eigenimages"*
- **Marois+2006,** *"Angular Differential Imaging: A Powerful High-Contrast Imaging Technique"*

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