

α Cen B

α Cen A



Sun

An Exoplanet Candidate in the Habitable Zone of α Centauri A

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Program Co-PIs: Charles Beichman (NASA JPL) and Dimitri Mawet (Caltech)

MIRI Observations: Jonathan Aguilar, Dean Hines, Wilson Joy Skipper, George Chapman, JWST FGS and Short- and Long-Range Planning Teams, STScI Director's Office

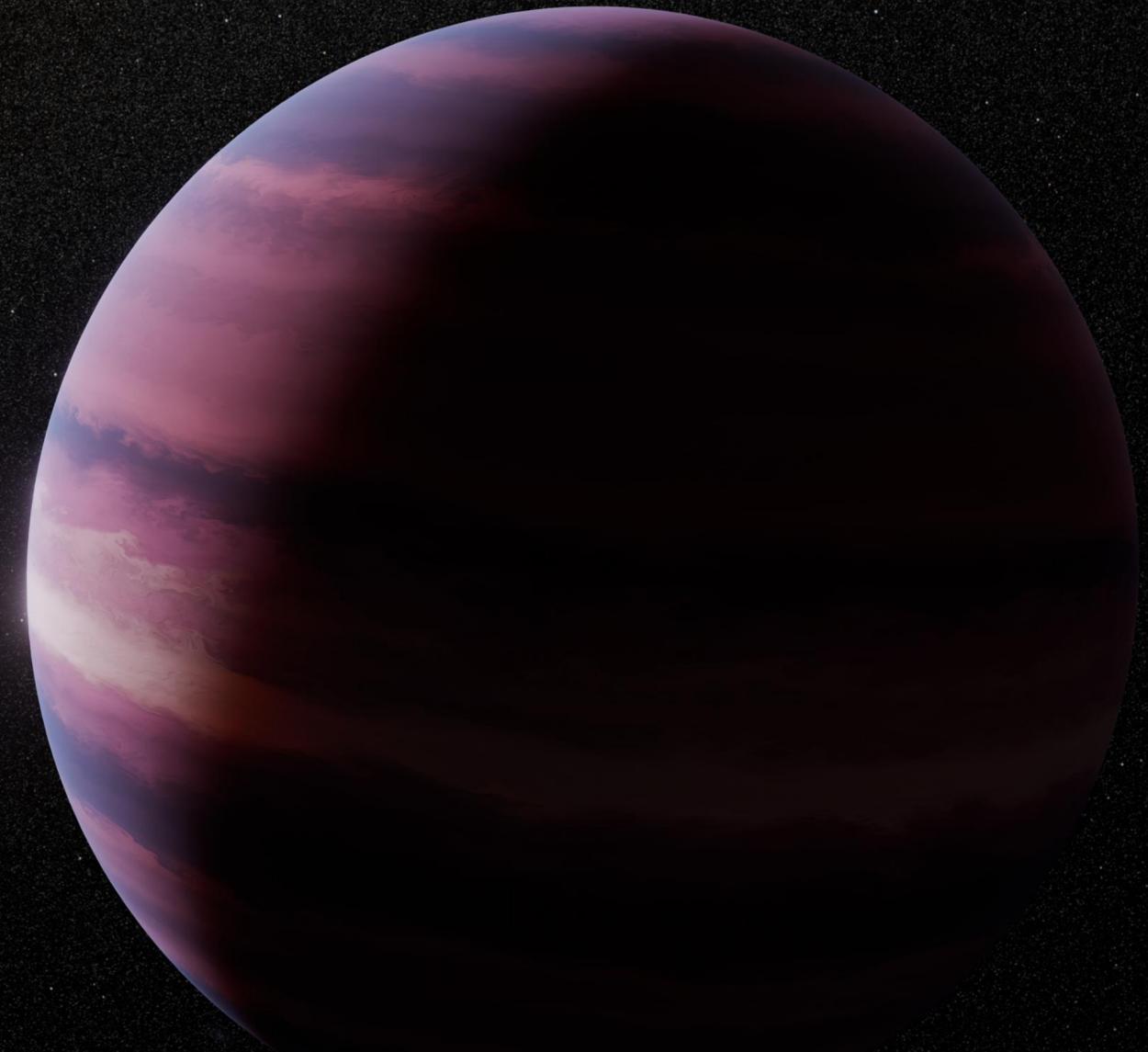
MIRI Data Reduction: William Balmer, Laurent Pueyo, Jorge Llop-Sayson, Anthony Boccaletti, Jarron Leisenring, Eugene Serabyn, Marie Ygouf, Ruslan Belikov, Michael Ressler, Alexis Bidot

Astrometry: Pierre Kervella, Rachel Akeson, Edward Fomalont

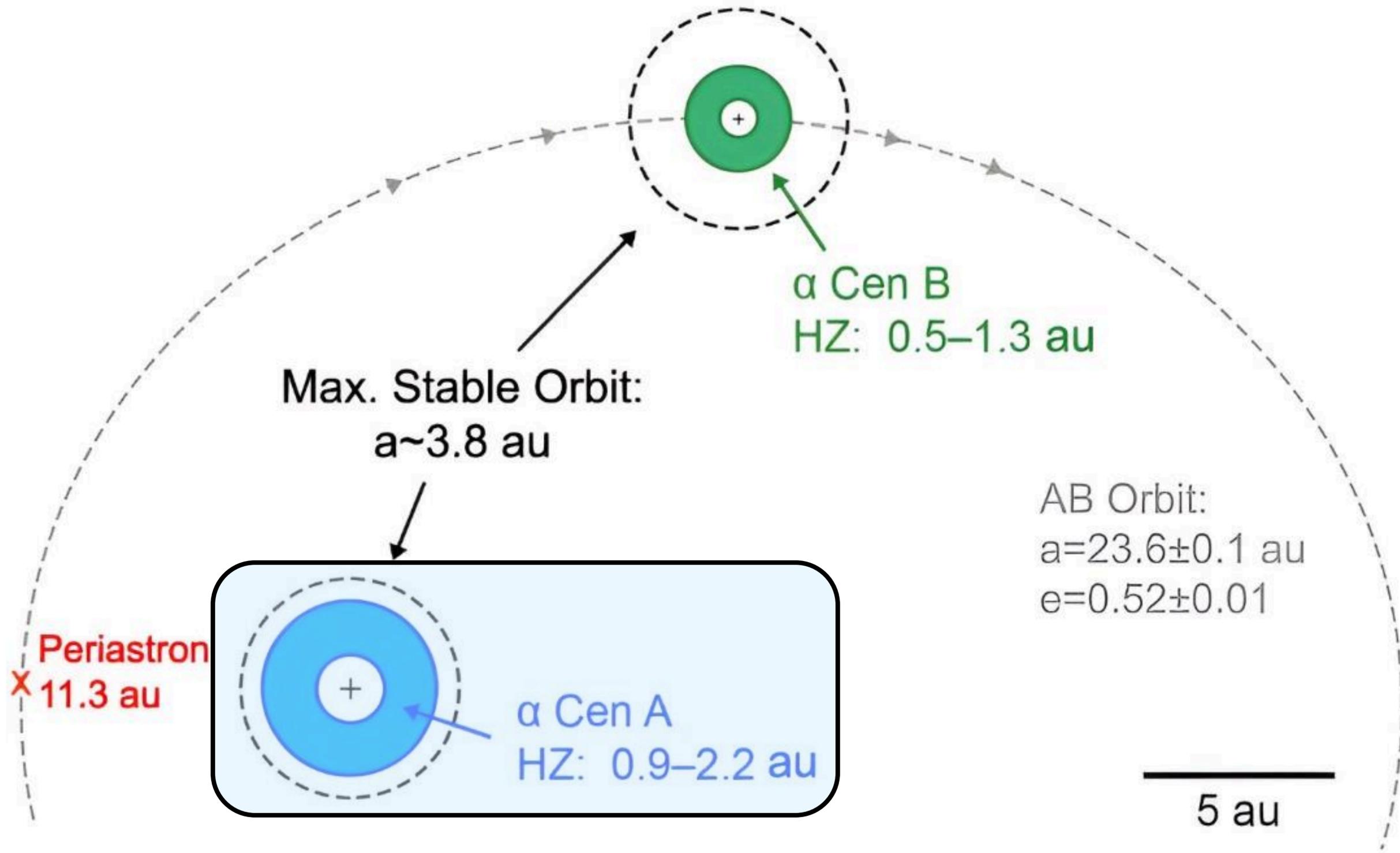
Orbits and Dynamics: Kevin Wagner, Billy Quarles, Jack Lissauer

Exozodi: Max Sommer, Mark Wyatt, Nicolas Godoy, Elodie Choquet, Pierre-Olivier Lagage

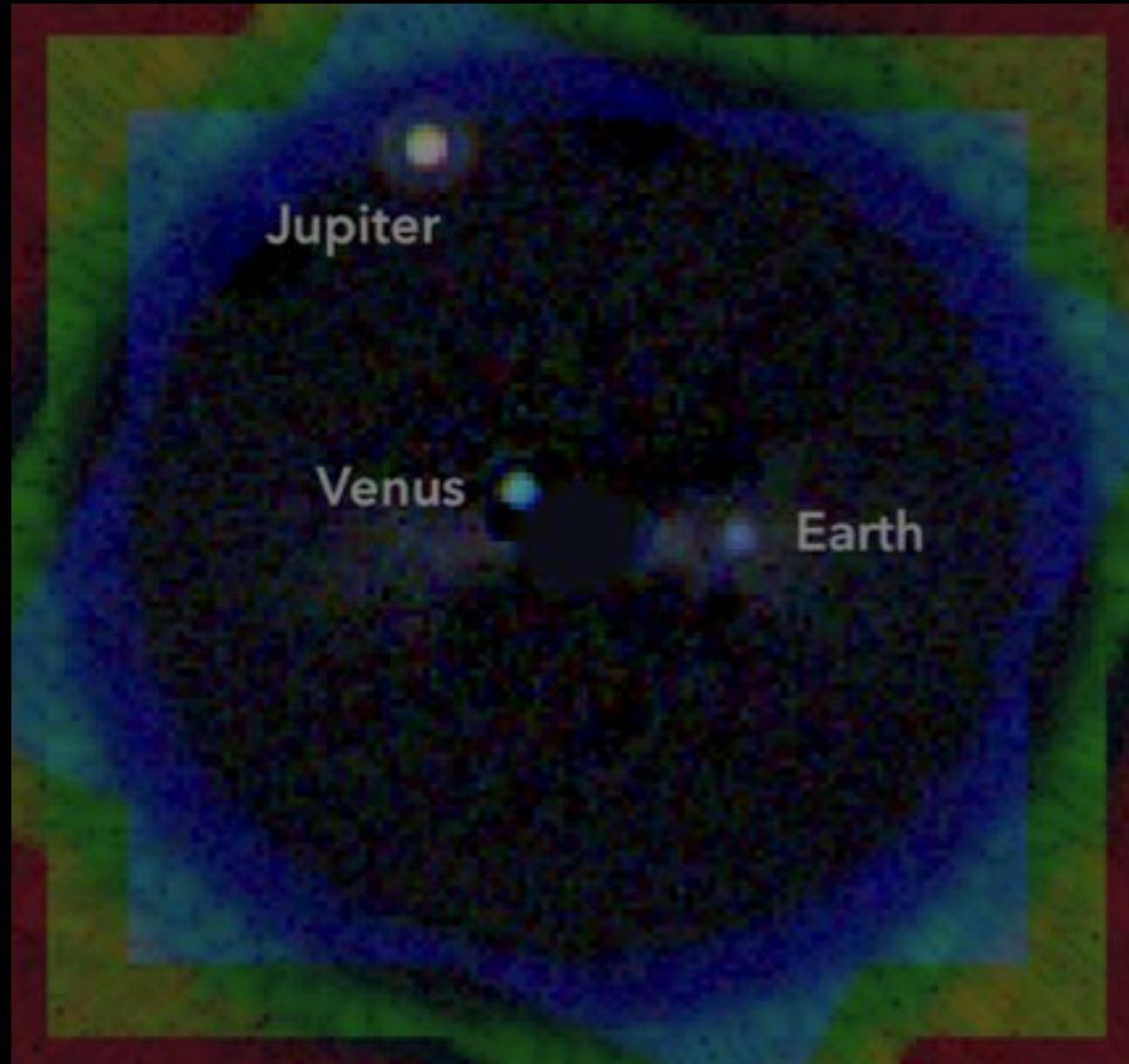
Planetary Atmospheres: Renyu Hu, James Mang, Mantas Zilinskas, Pascal Tremblin, Thomas Henning



The α Centauri AB System

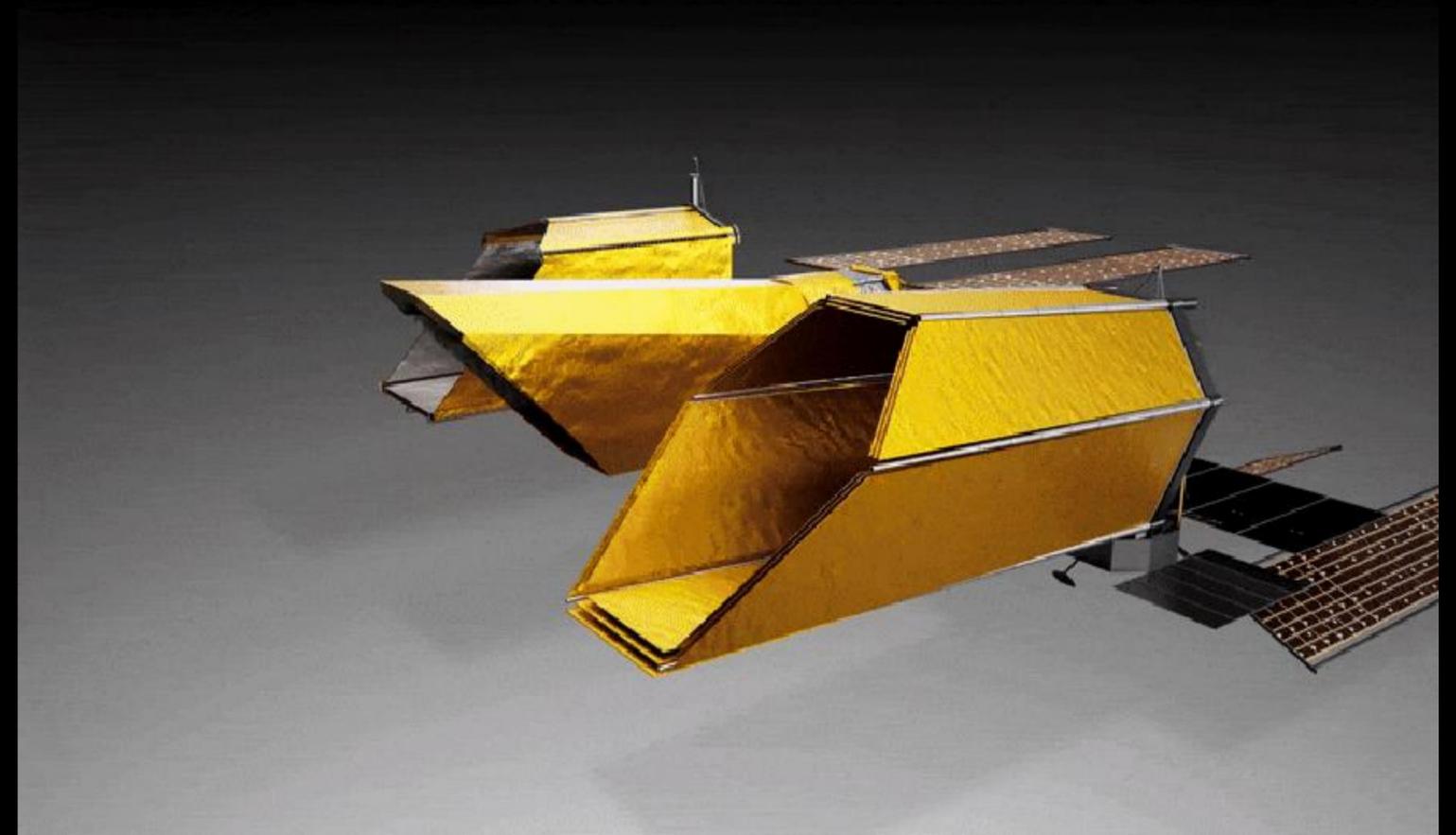


The Ultimate Goal: Search for Life



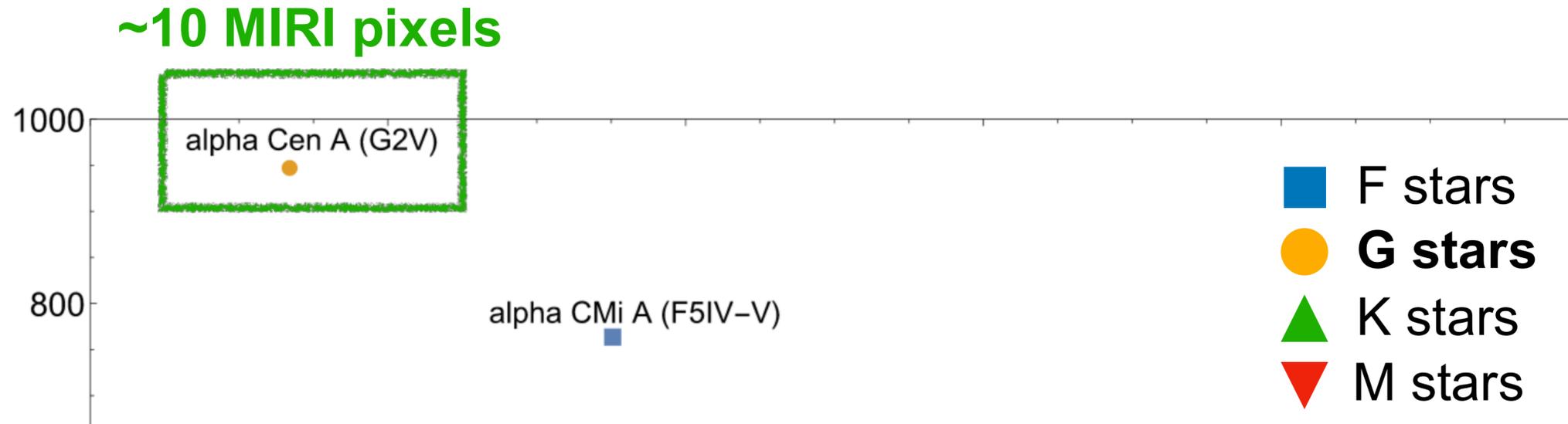
LUVOIR Report
(2019)

The Habitable Worlds Observatory*

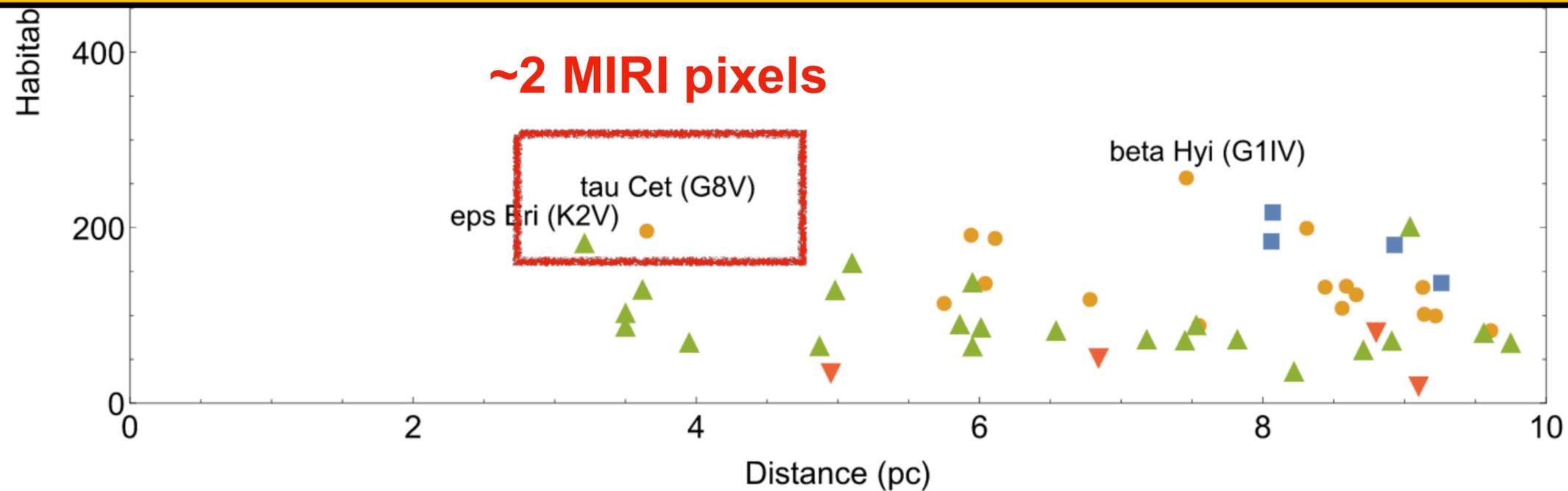


NASA GSFC/Conceptual Image
Labs

Why α Centauri A?



Any planet is ~7.5x brighter than around τ Ceti



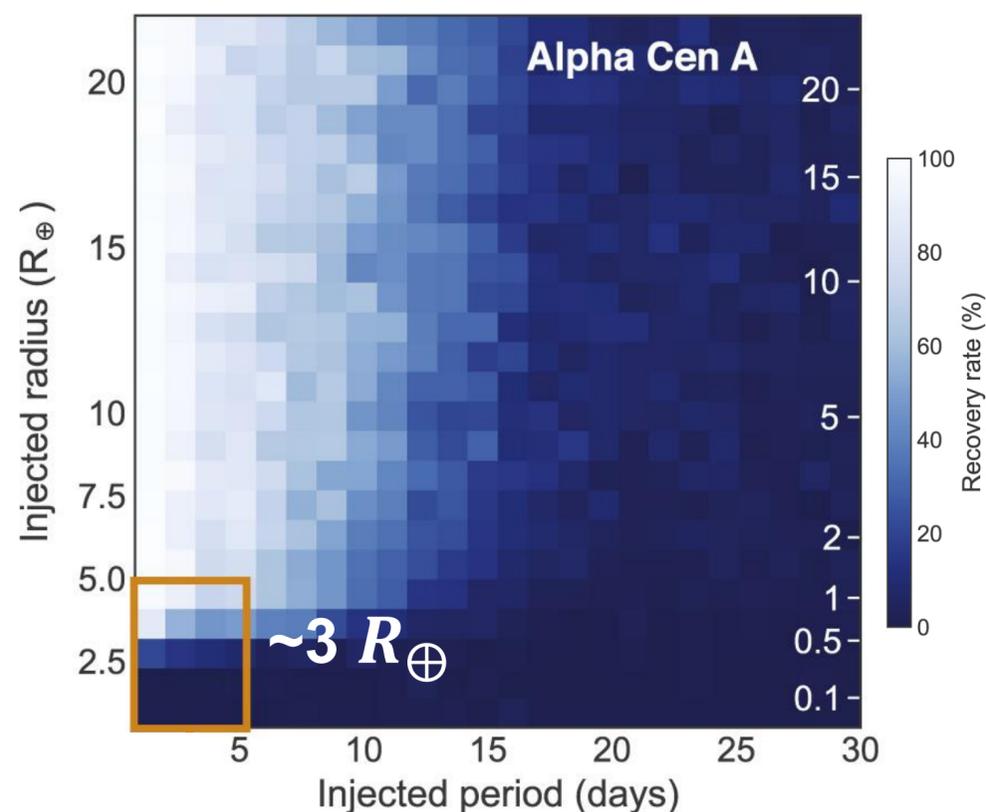
Prior Knowledge about Planets around α Cen A

No confirmed planets

Transit Observations

No detections

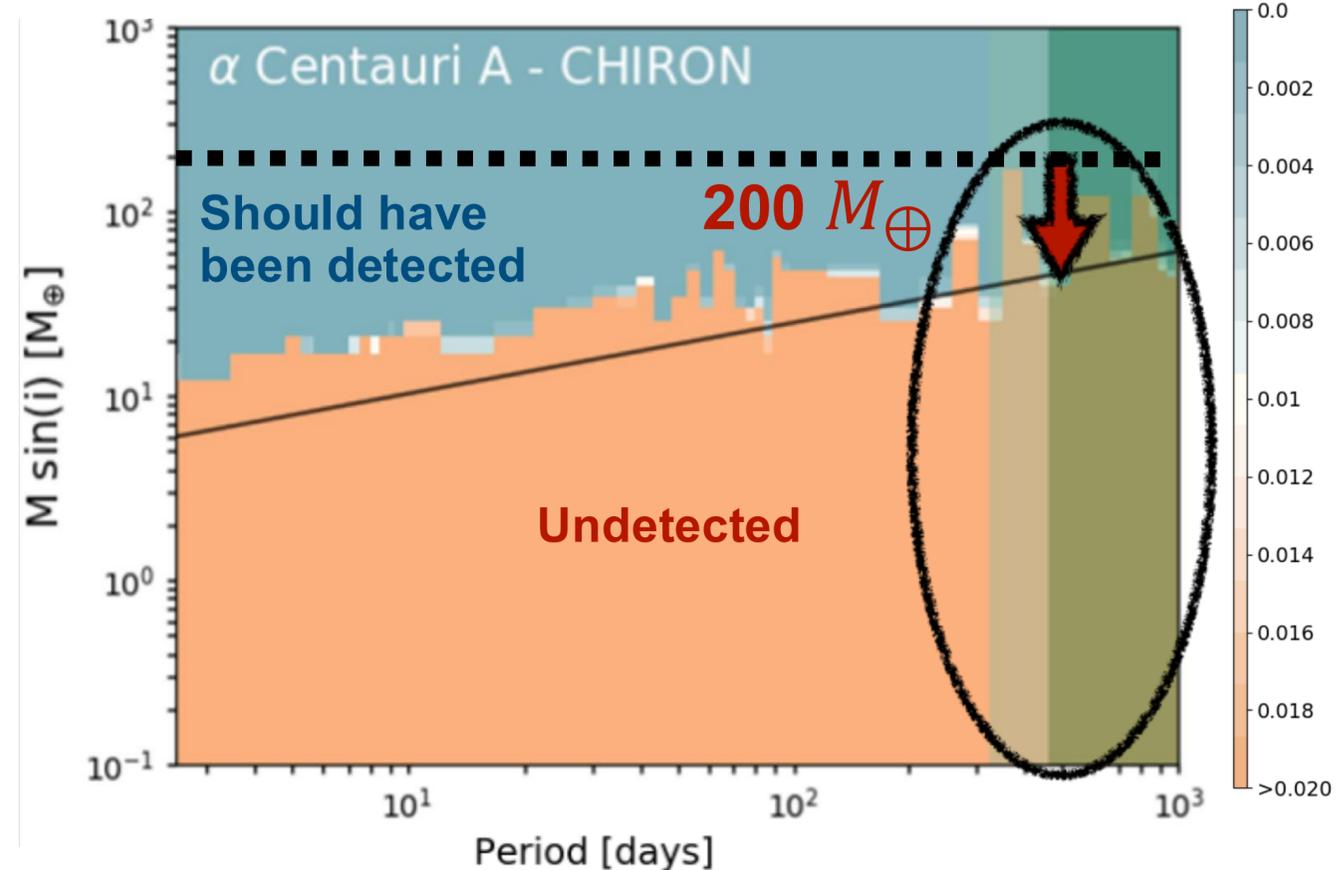
Krishnamurthy et al. 2021



Radial Velocity Observations

No detections

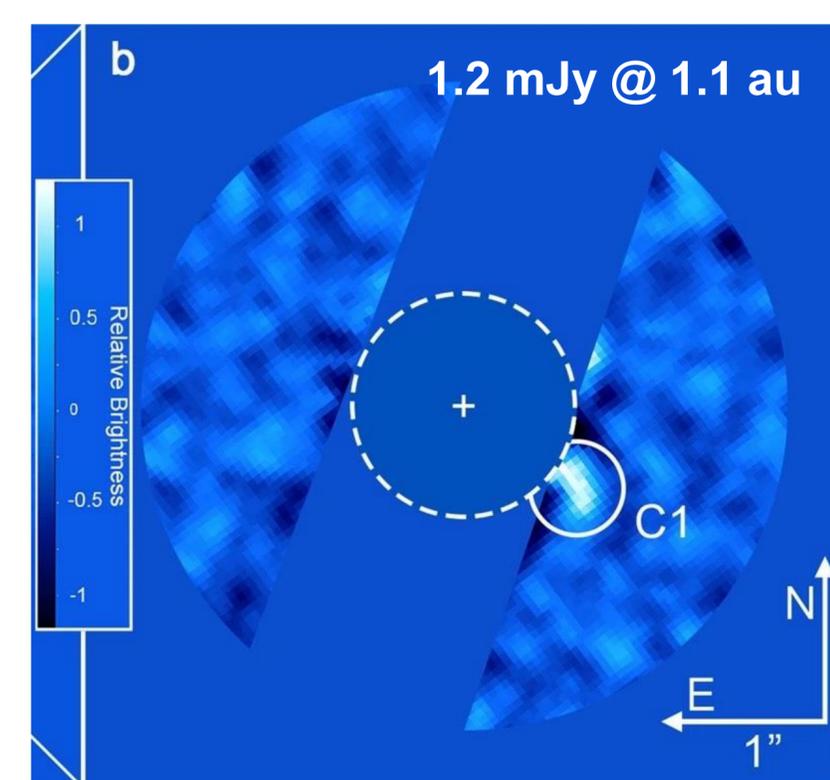
Zhao et al. 2018



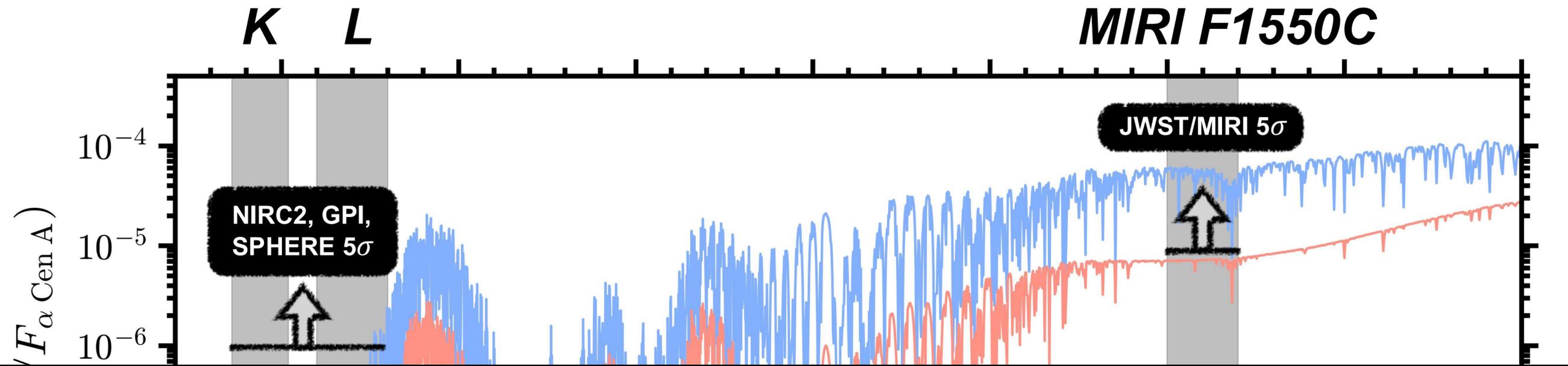
VLT/NEAR 10-11.25 μm Imaging

Candidate C1

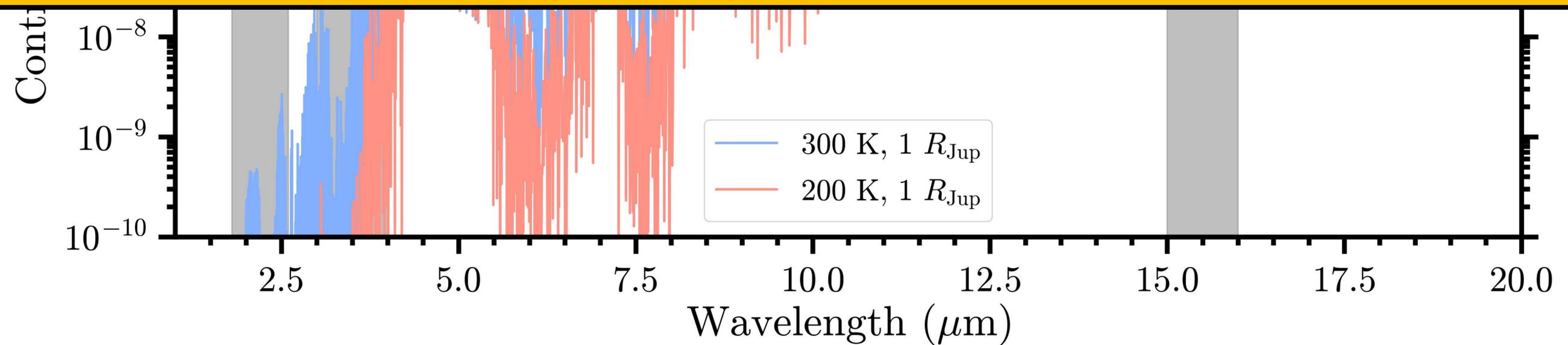
Wagner et al. 2021



Why JWST/MIRI?



JWST can image giant planets heated by α Cen A in the HZ



How do you observe the third brightest star?

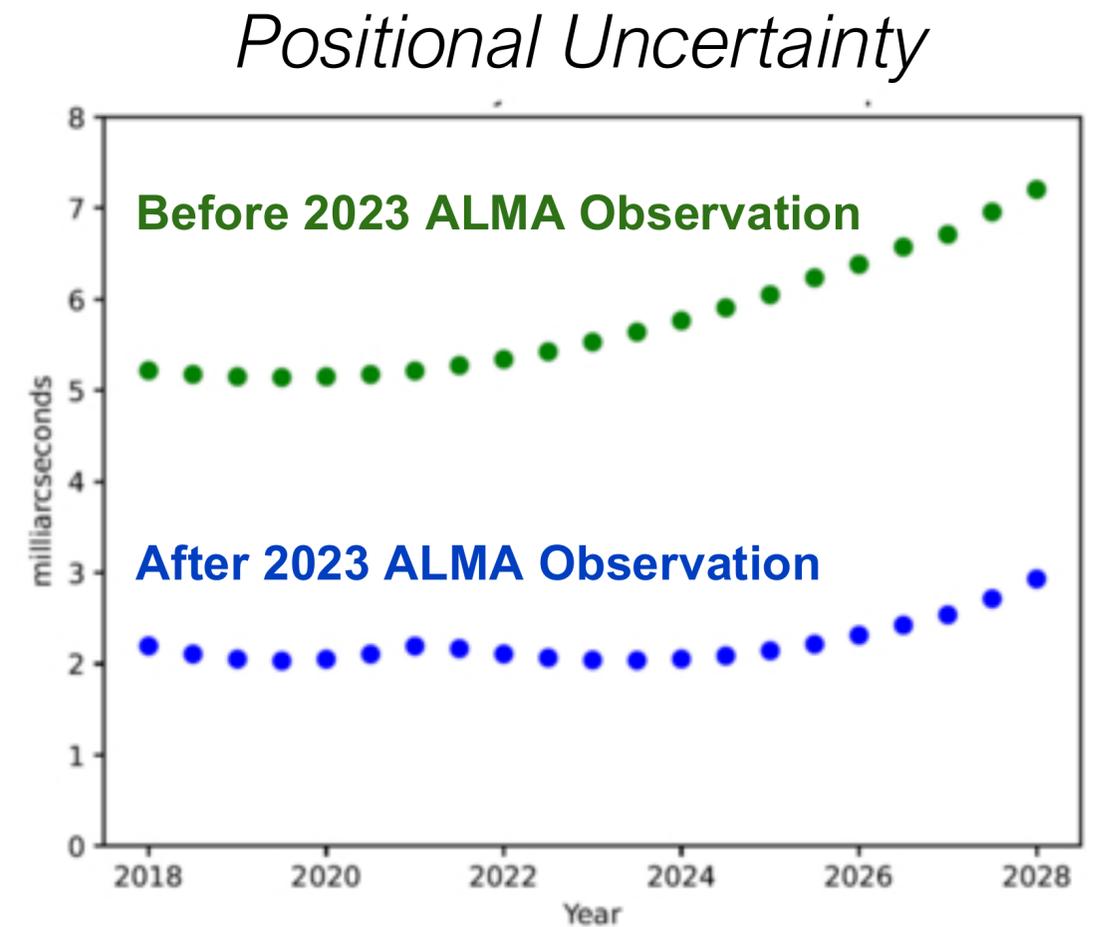
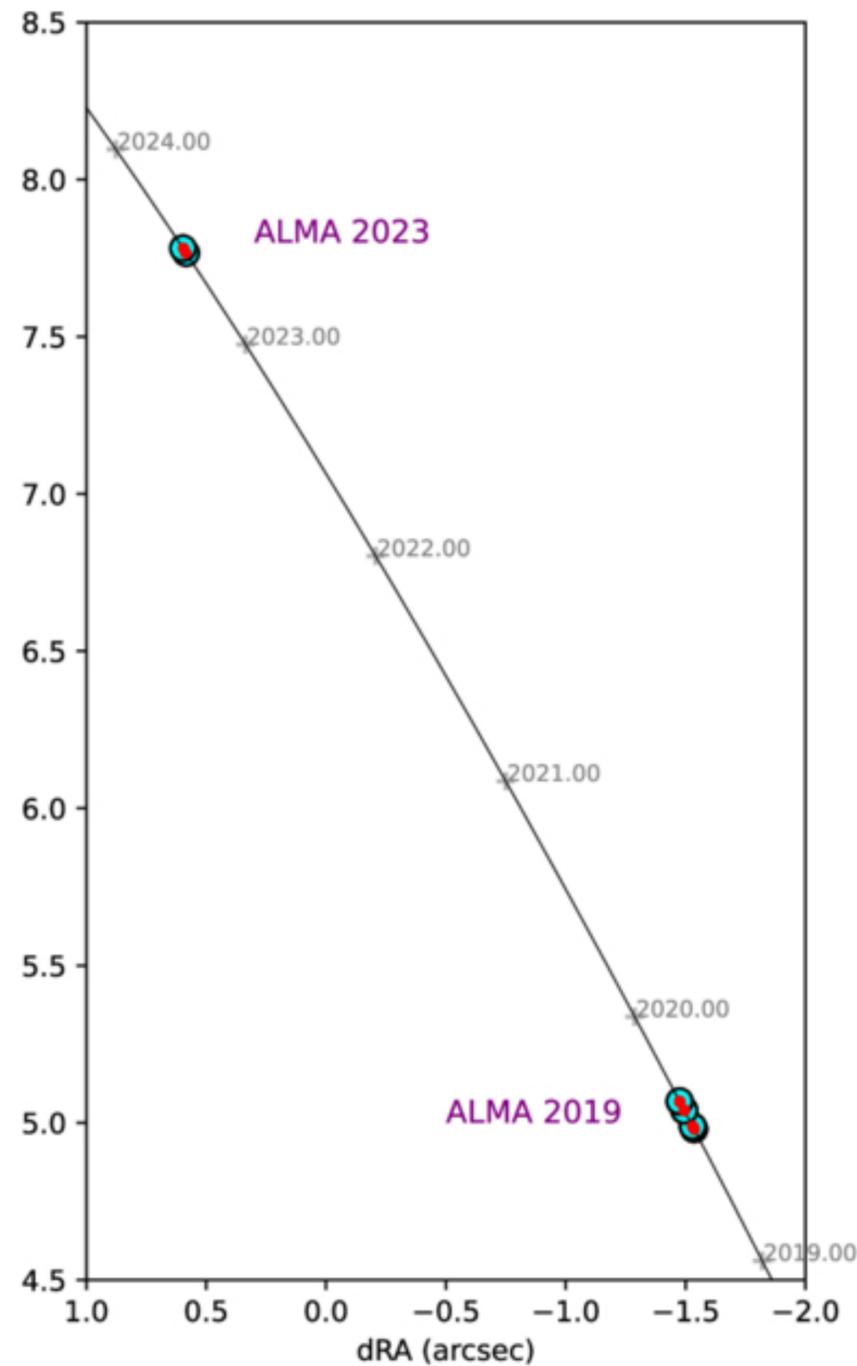
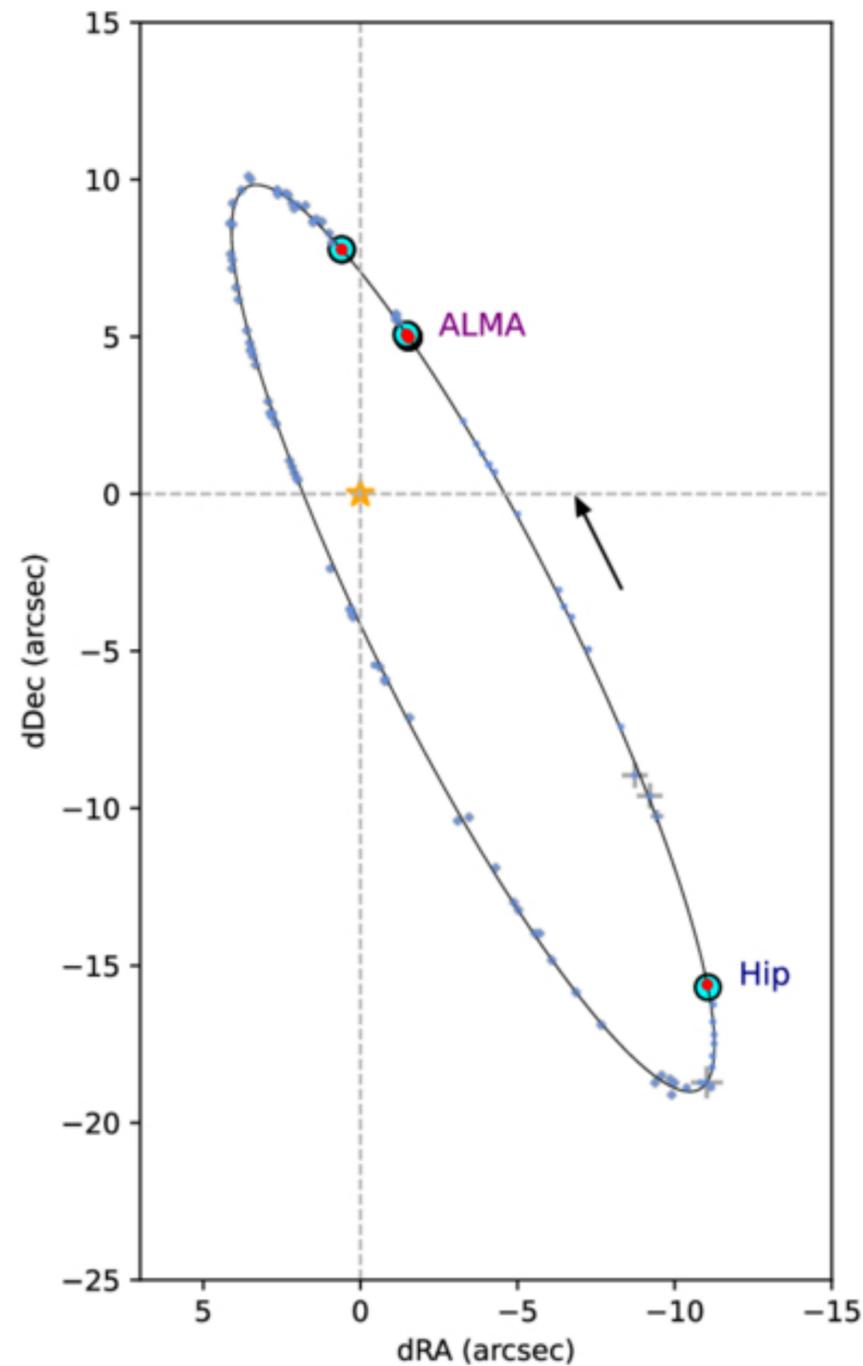
The MIRI coronagraph needs to be centered on the star with an **error <10 mas**.

Problem 1: α Cen A is moving at **~ 10 mas/day (!)**

Problem 2: α Cen A (**$K = -2$ mag**) saturates MIRI TA

Overcoming the Challenge of Target Acquisition

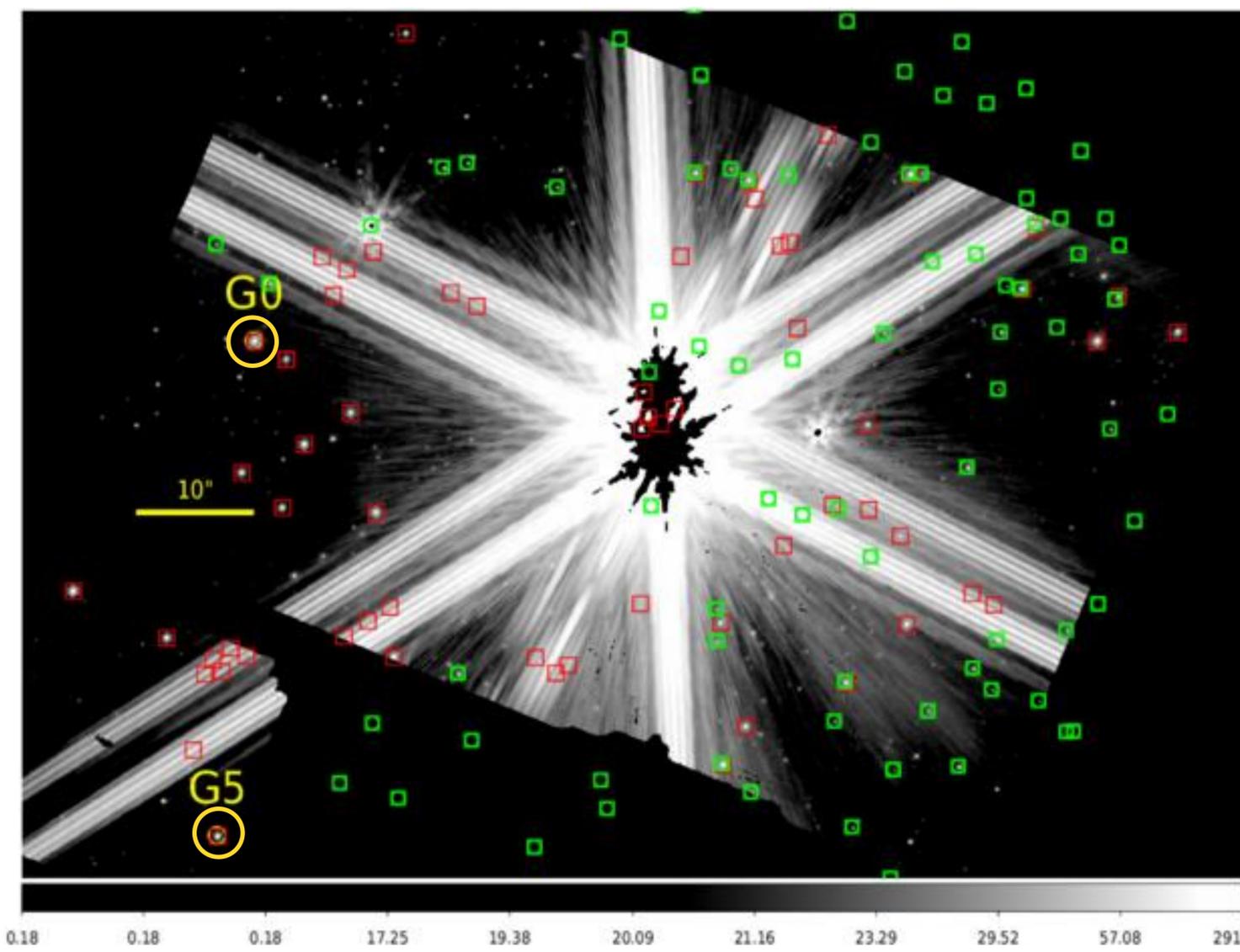
(1) Determine the position of α Cen AB to ~ 2 mas precision



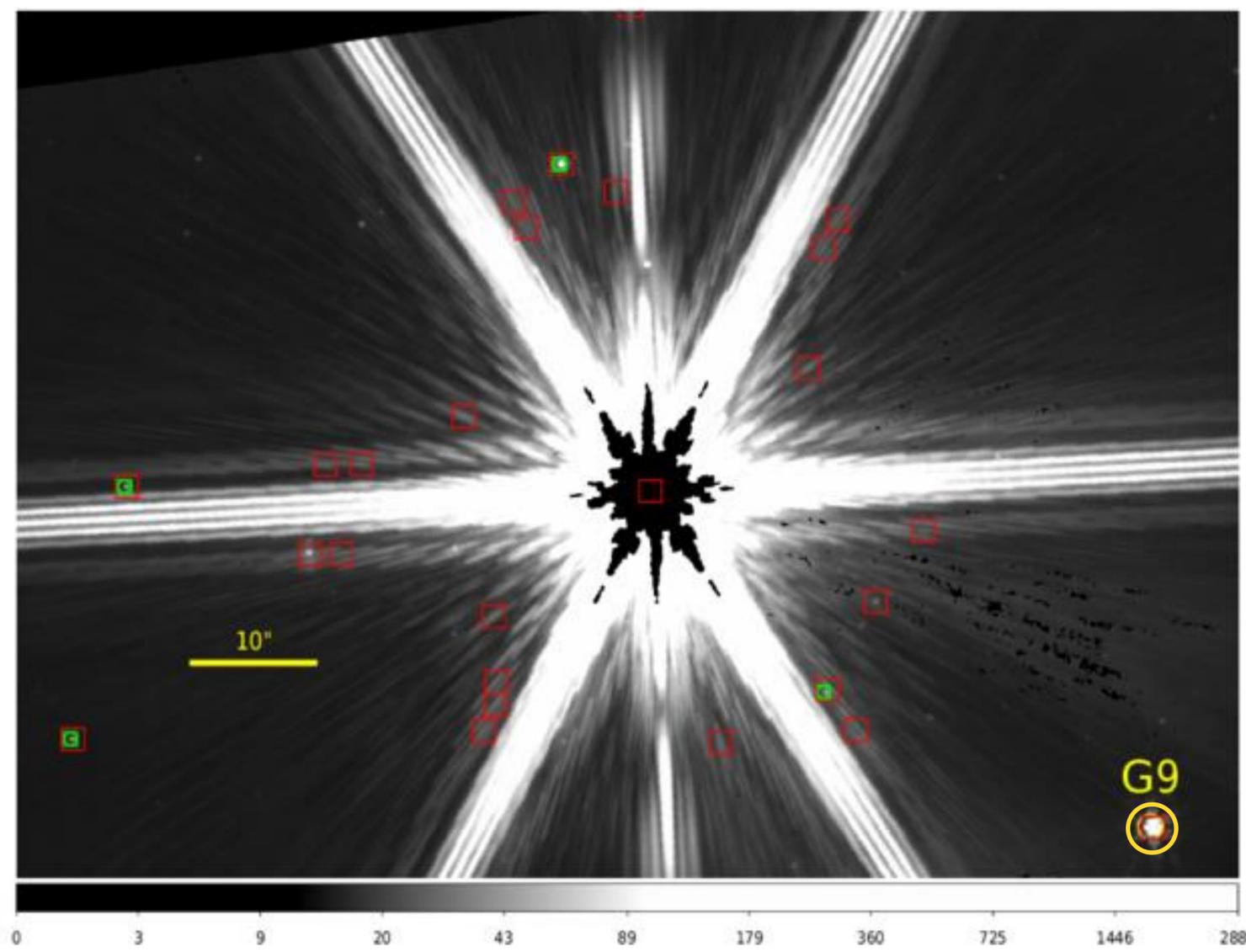
Overcoming the Challenge of Target Acquisition

(2) Identify Gaia stars suitably bright in F1000W in the field (June 2023)

Alpha Cen AB



Epsilon Muscae (Reference Star)

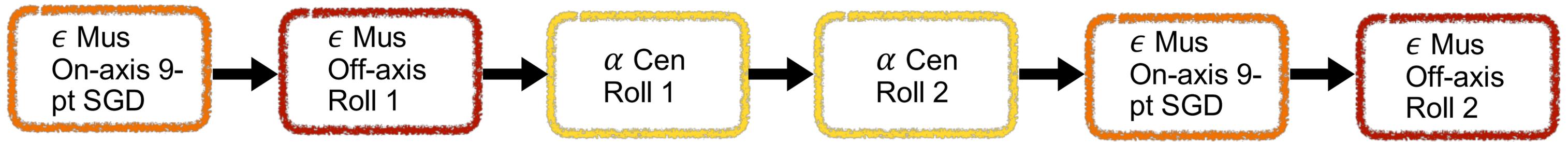


Sequence of Observations: Three Epochs of JWST Imaging

Aug 2024: JWST C1 GO Program #1618 (PI: Beichman, Co-PI: Mawet)

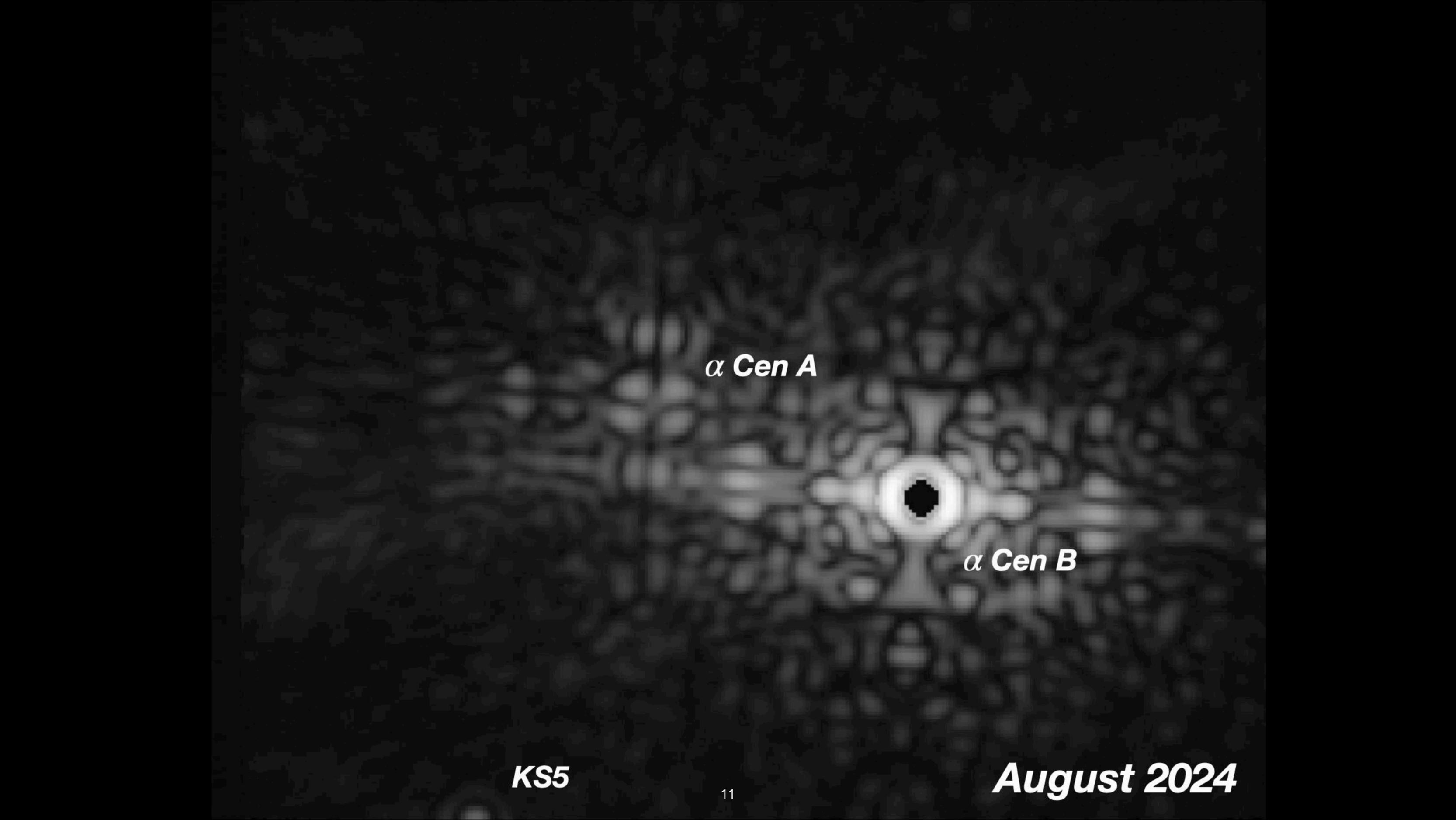
Feb 2025: JWST C3 DDT Program #6797 (PI: Beichman, Co-PI: **Sanghi**)

Apr 2025: JWST C3 DDT Program #9252 (PI: Beichman, Co-PI: **Sanghi**)



aCen AB + planet

Repeat

A grayscale astronomical image of the Alpha Centauri system. The central region shows two stars, labeled α Cen A and α Cen B, which are part of a binary system. α Cen B is the brighter star and is surrounded by a prominent white circular artifact, likely a coronagraphic mask. The background is filled with a dense field of stars, with a few brighter ones visible. The labels are in a white, sans-serif font.

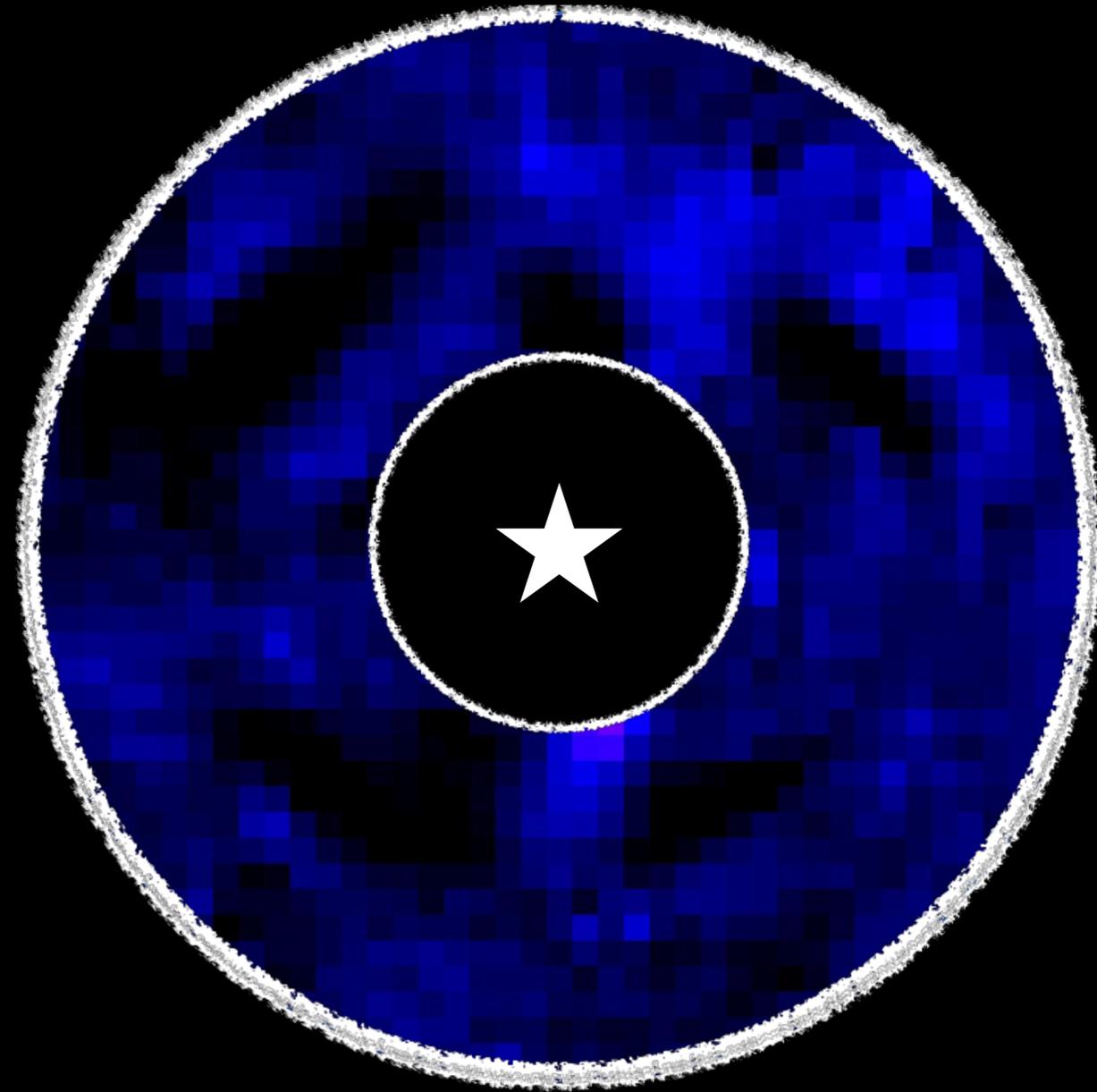
α Cen A

α Cen B

KS5

August 2024

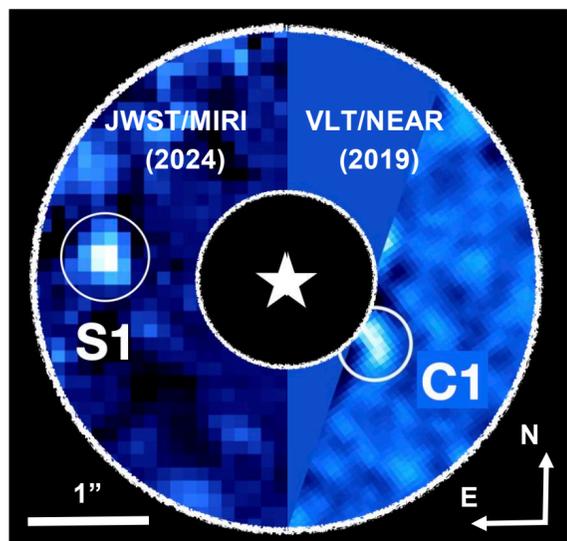
***James Webb Space Telescope
(April 2025)***



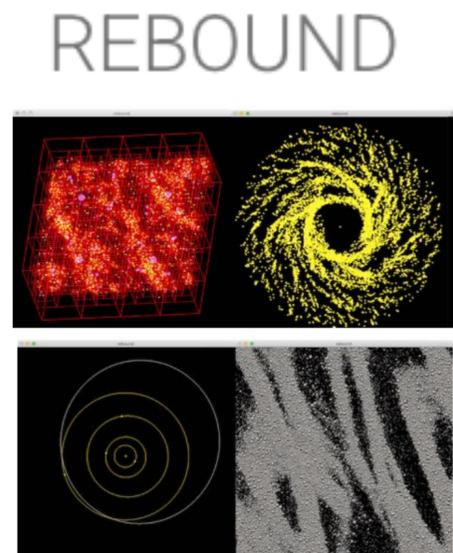
***See Sanghi & Beichman et al. (2025) for data reduction, artifact testing, and
background + foreground source rejection***
Breakthrough NEAR Project

Orbital and Physical Properties

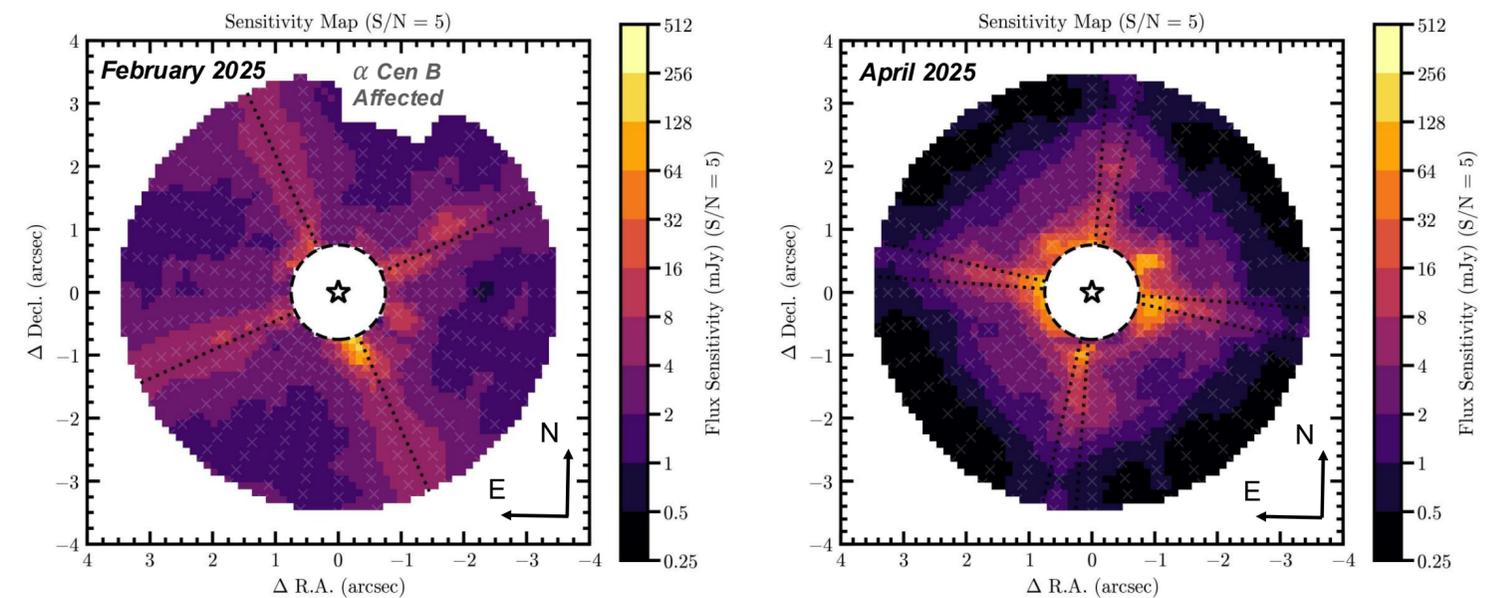
(1) Fit Orbits to S1+C1



(2) Select Stable Orbits



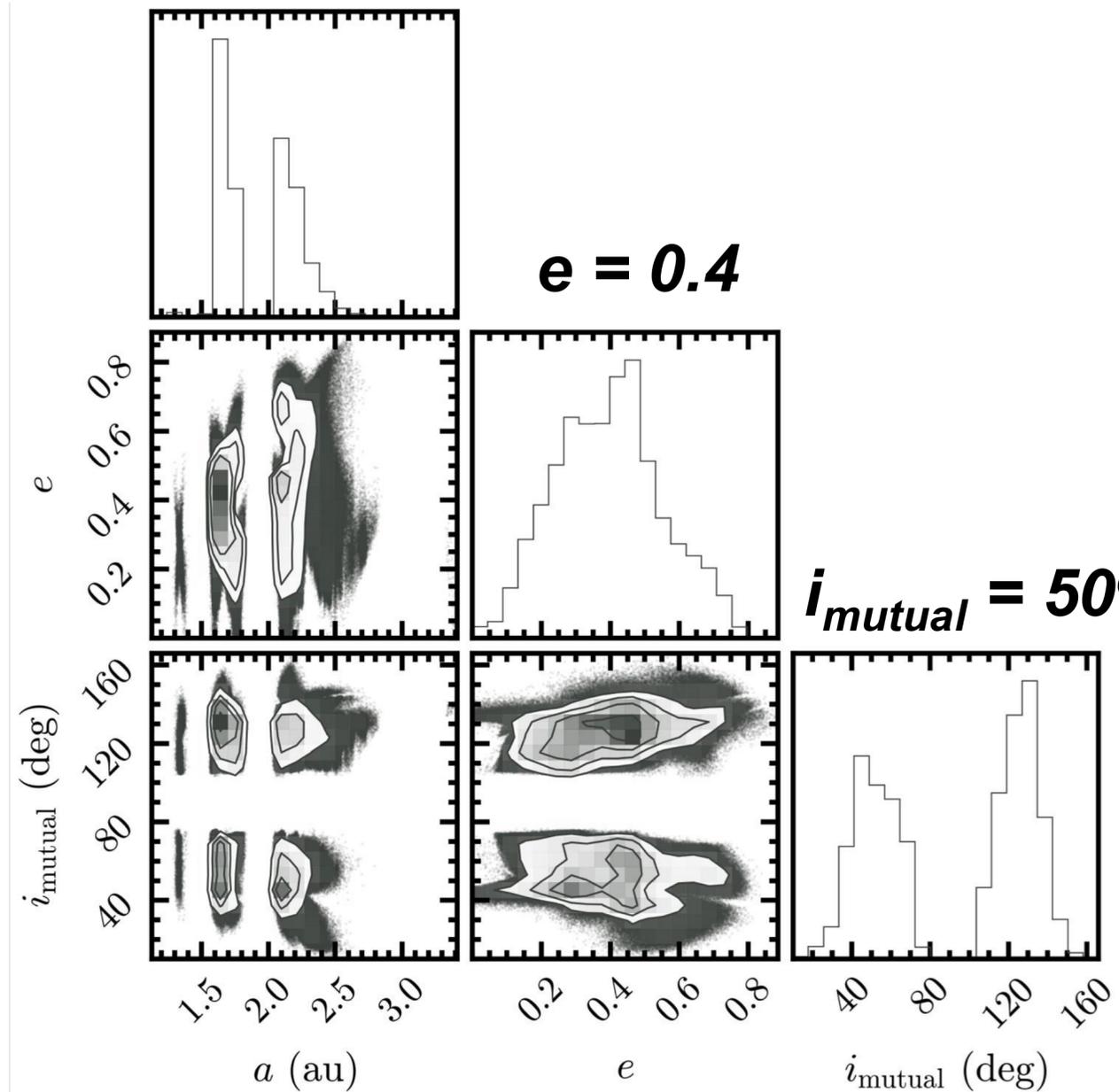
(3) Find Orbits Consistent with Non-Detections



52% of Stable S1+C1 Orbits are Consistent with February and April 2025 Non-Detections!

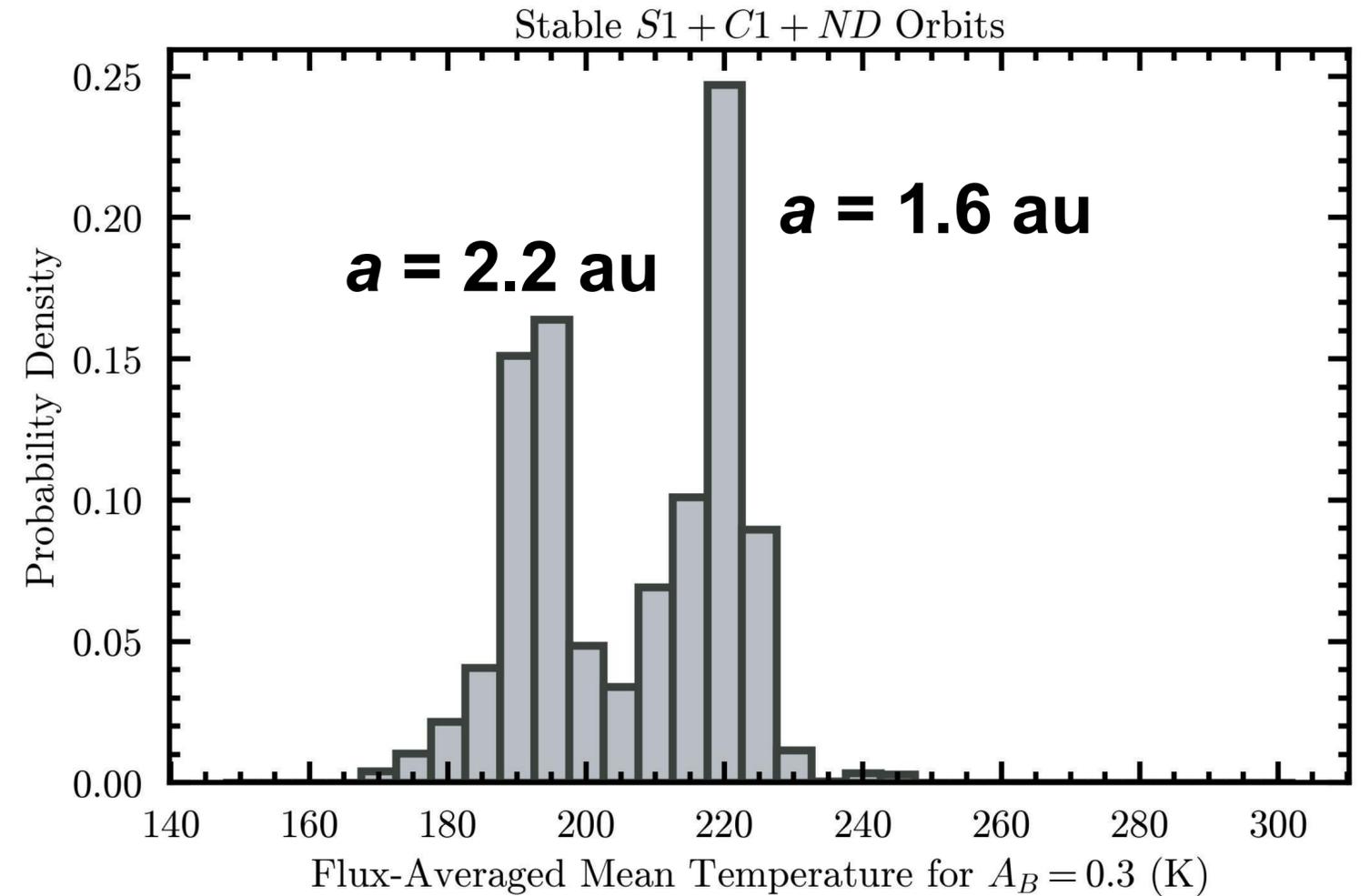
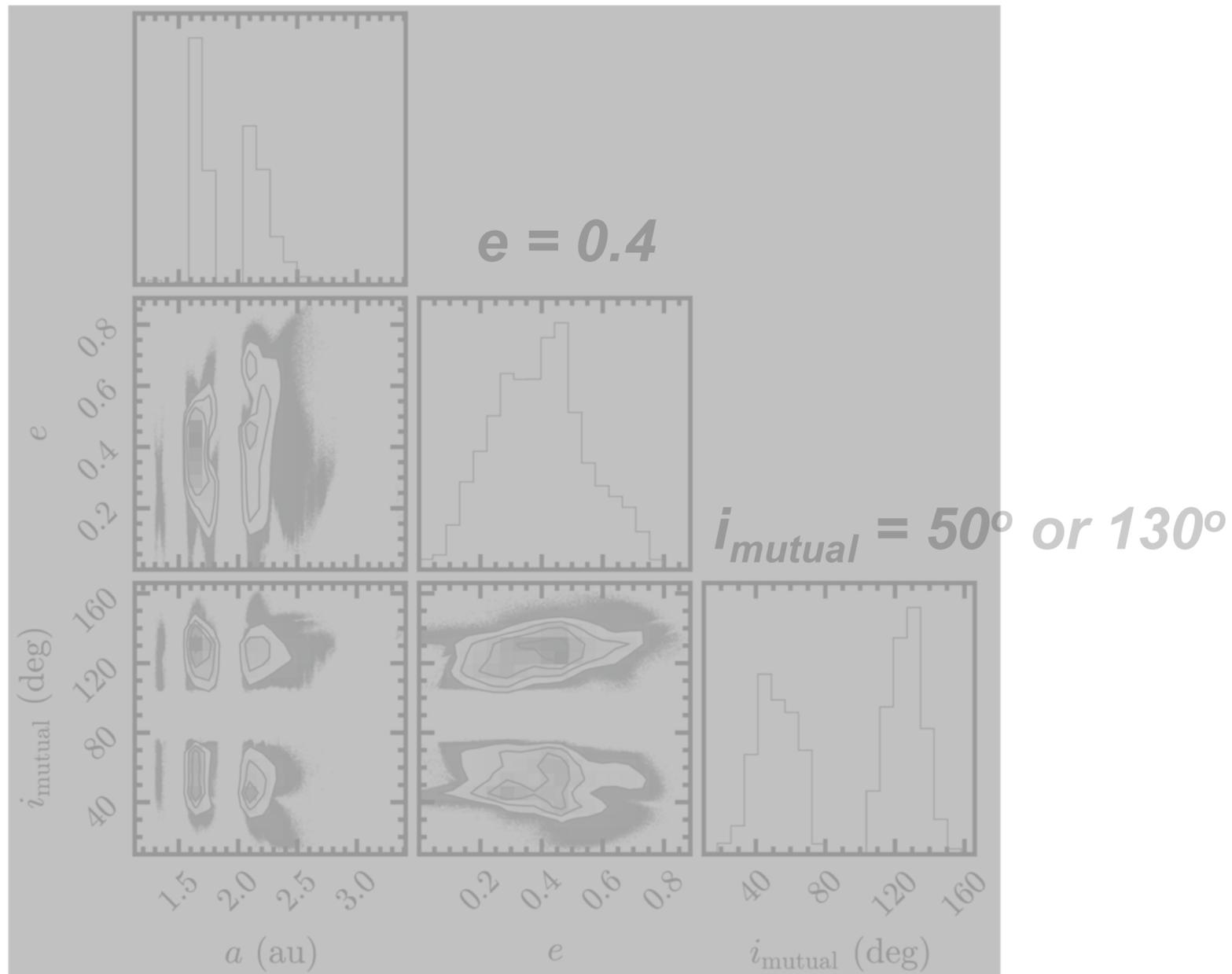
Orbital and Physical Properties

$a = 1.6 \text{ au}$ or 2.1 au



Orbital and Physical Properties

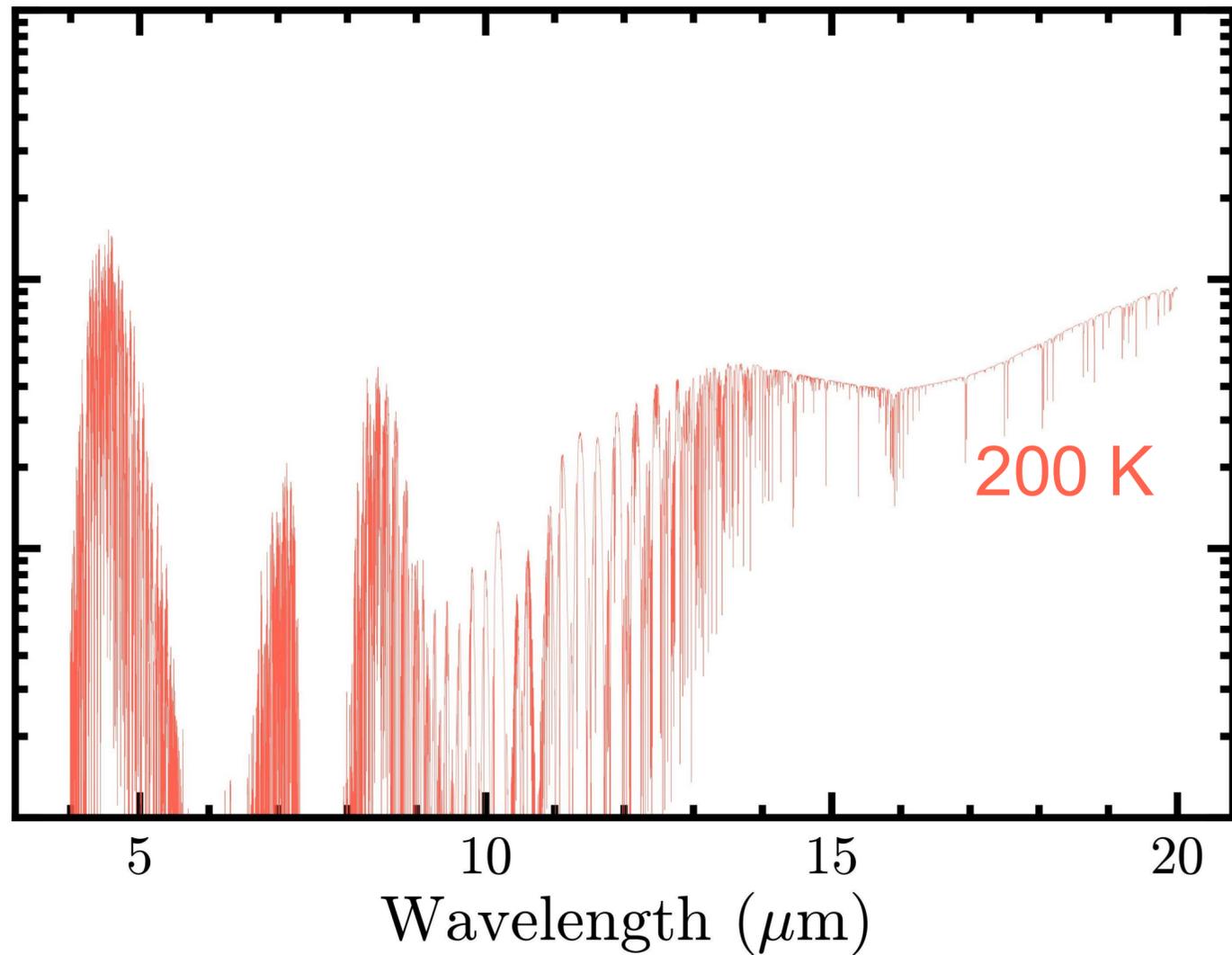
$a = 1.6 \text{ au or } 2.1 \text{ au}$



Orbit \Rightarrow **Temperature** \Rightarrow **Flux**

Photometry can constrain the orbit!

Orbital and Physical Properties

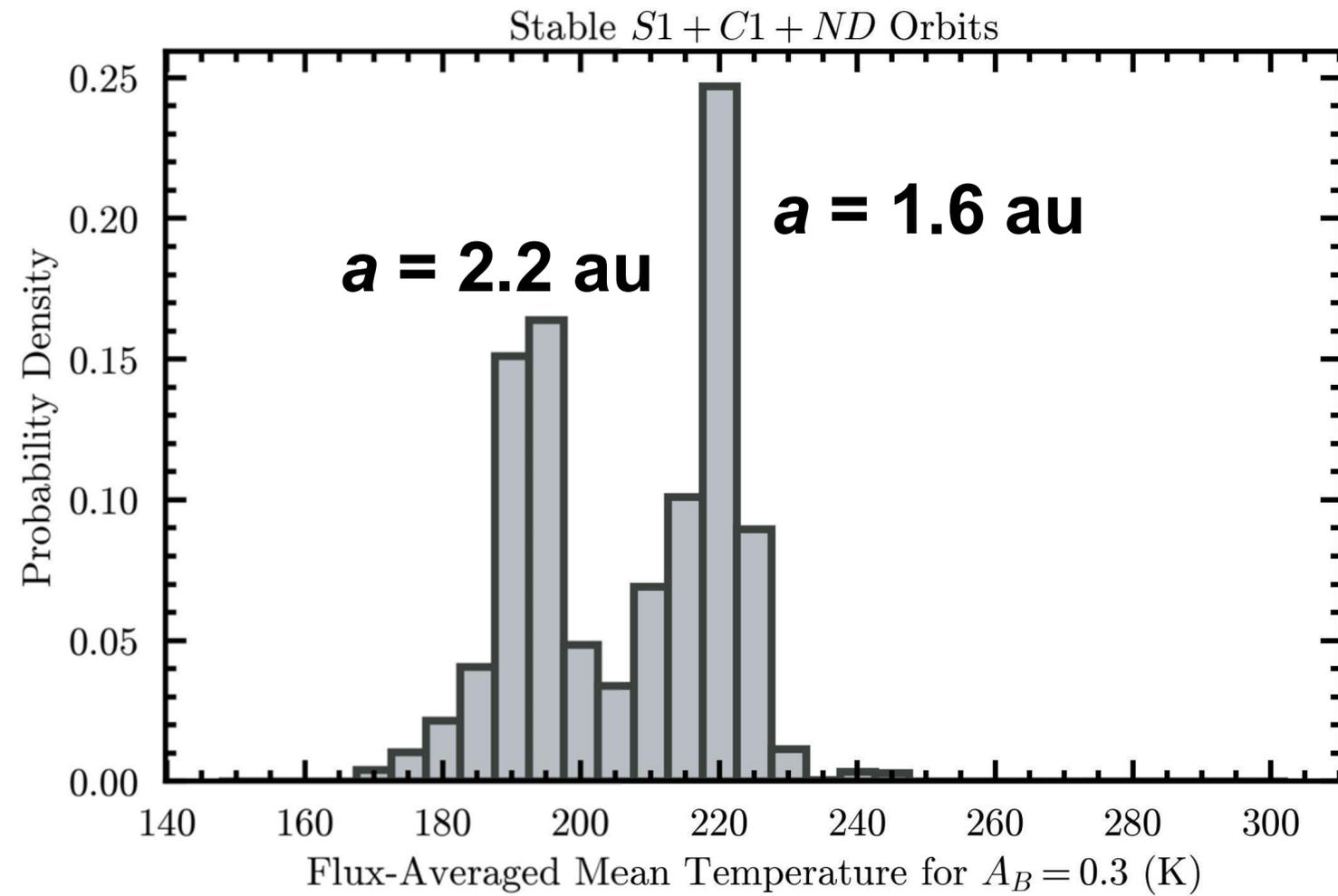


$$\times \left(\frac{R_p}{D} \right)^2 = 3.5 \text{ mJy (15.5 } \mu\text{m)}$$

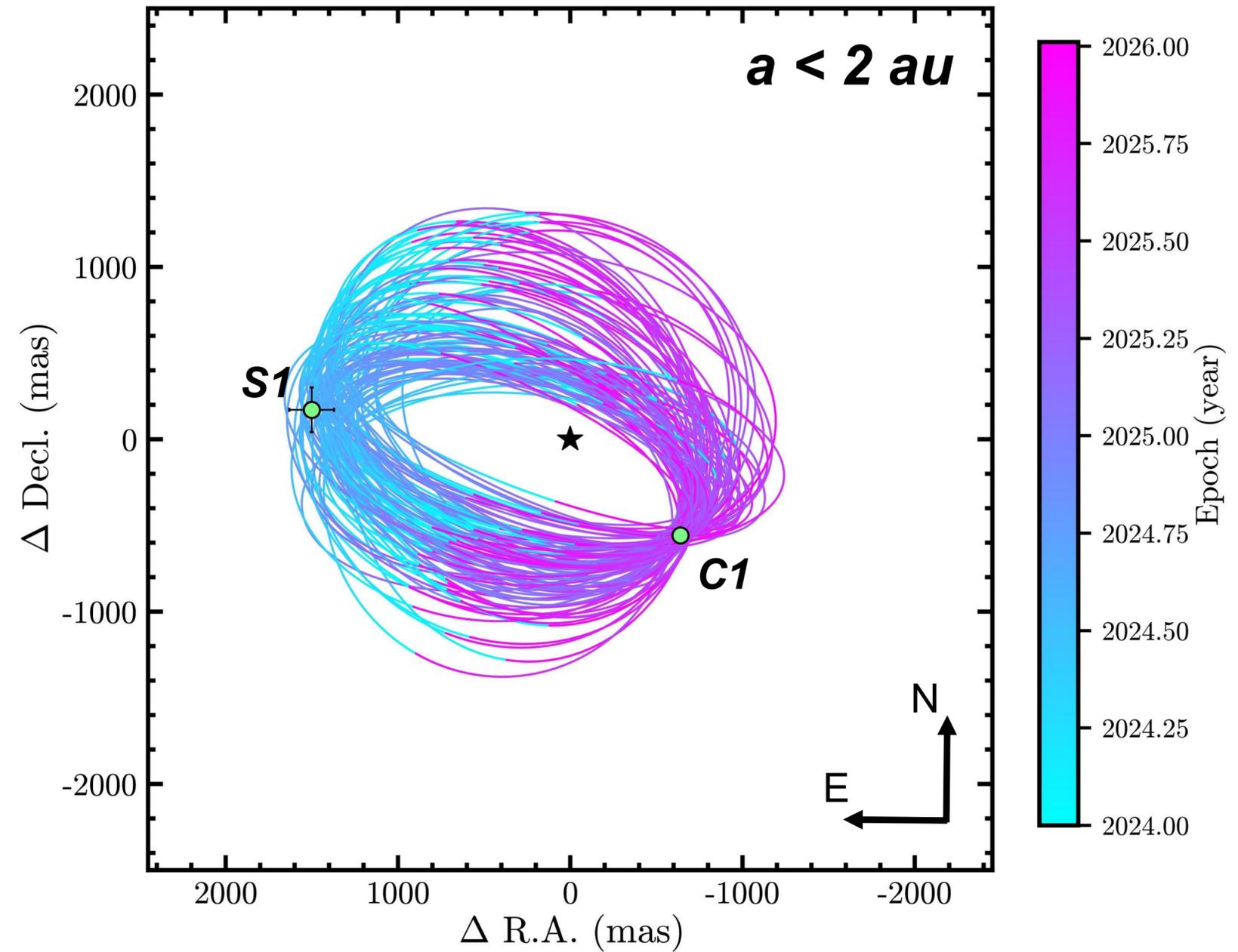
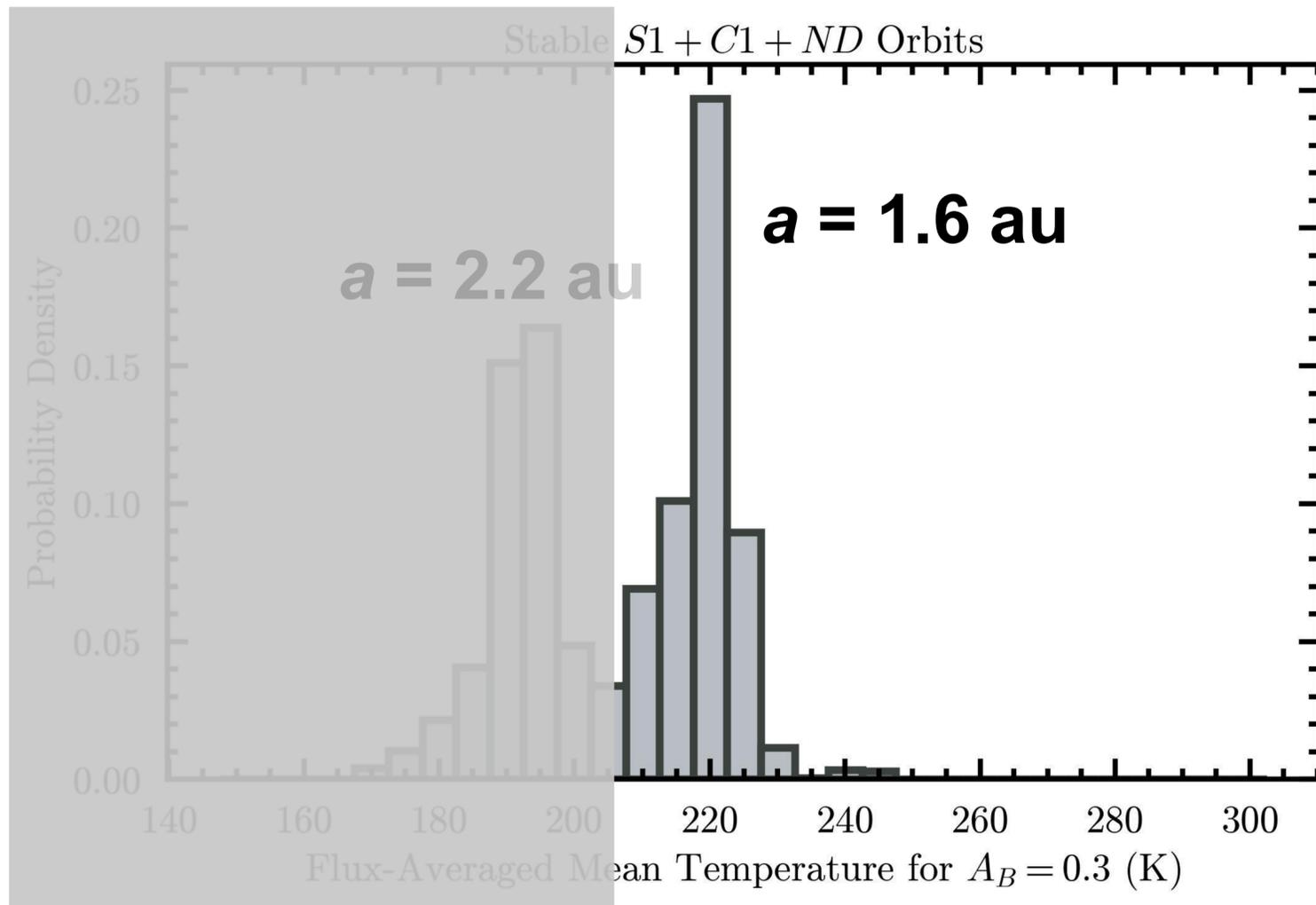
$>1.7 R_{\text{Jup}}$ (!)

1.34 pc

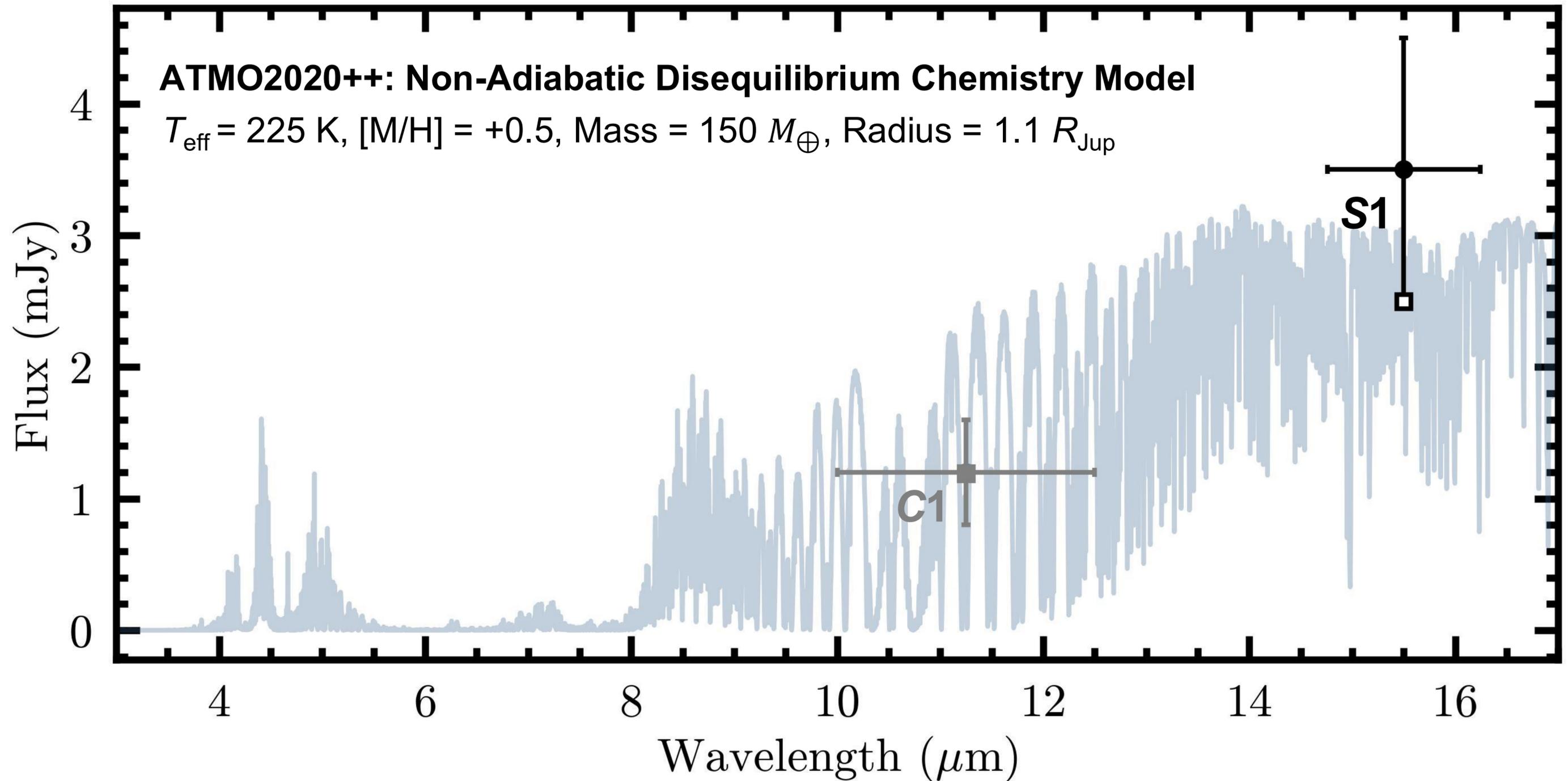
Orbital and Physical Properties



Orbital and Physical Properties

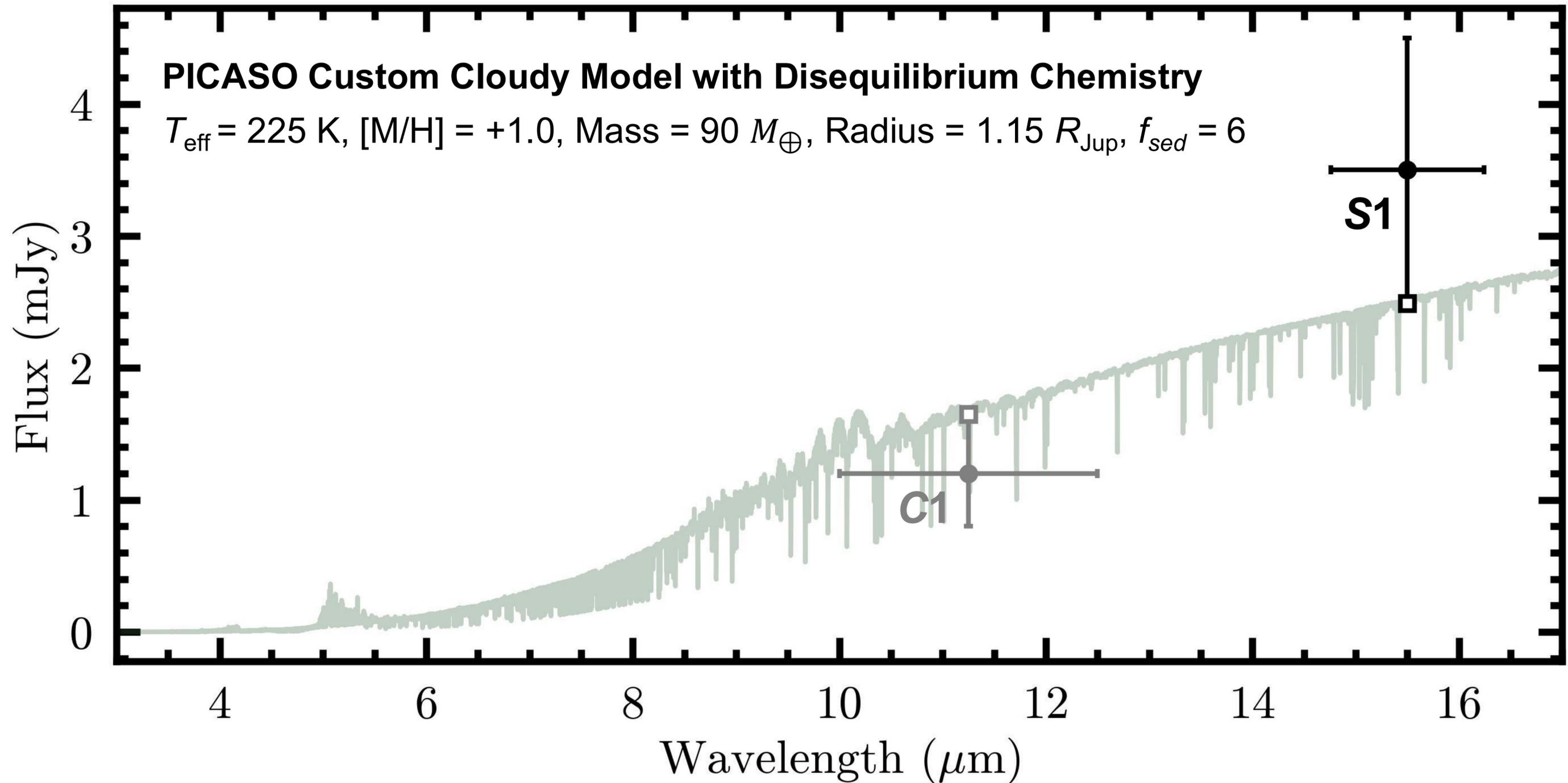


Orbital and Physical Properties



Model from Leggett & Tremblin (2023, 2024)

Orbital and Physical Properties



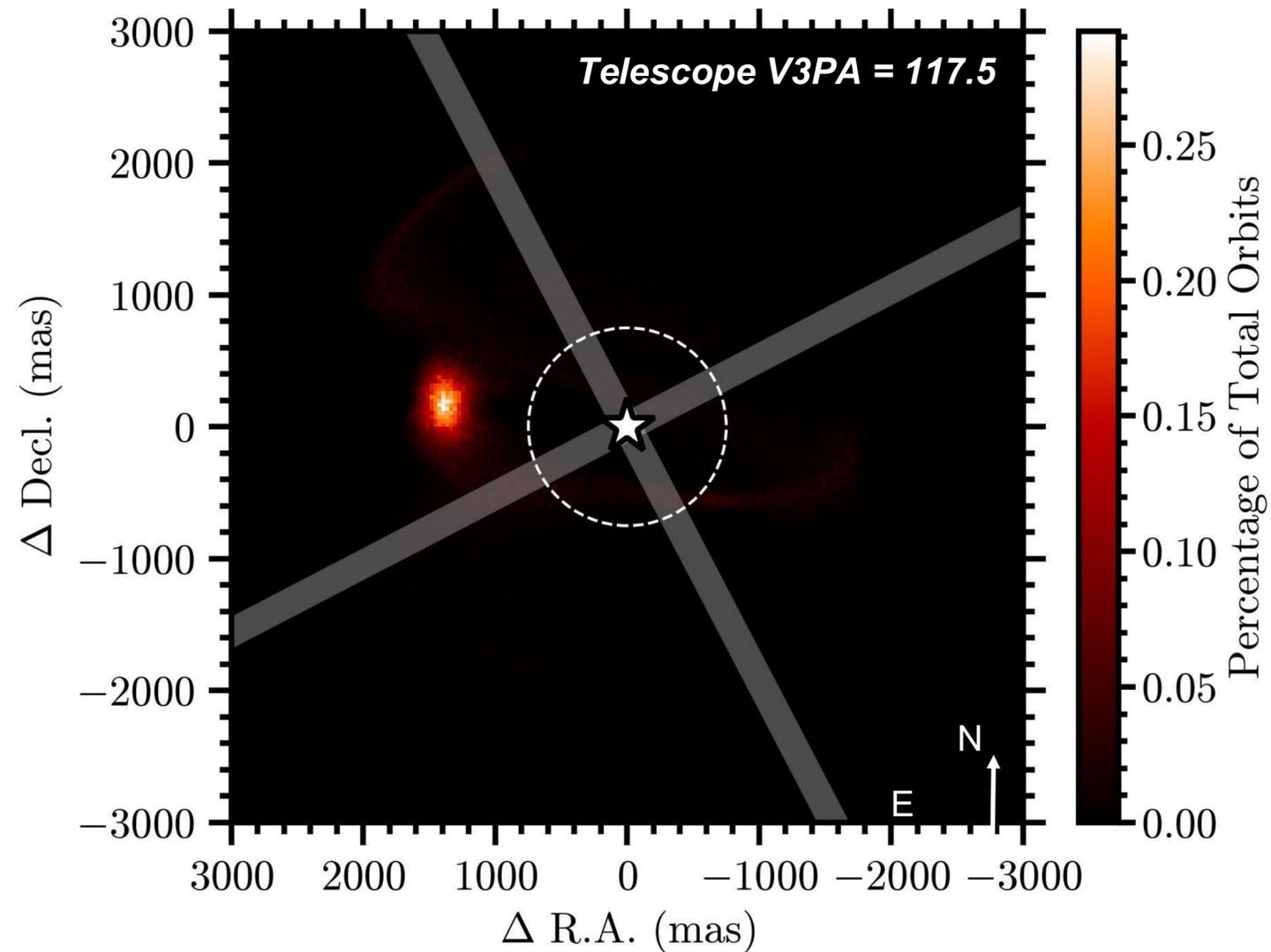
Model from Mang et al. (in preparation)

What's next?

Recovery and Confirmation

JWST Cycle 5

Prediction for August 15, 2026

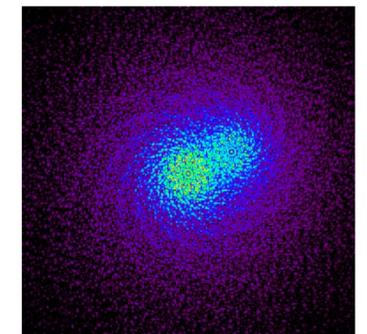
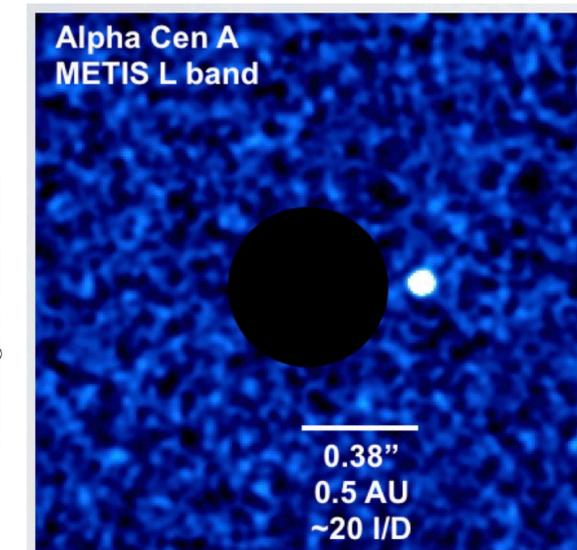
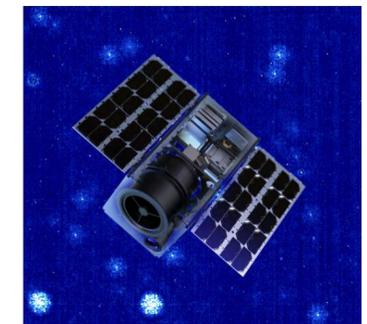
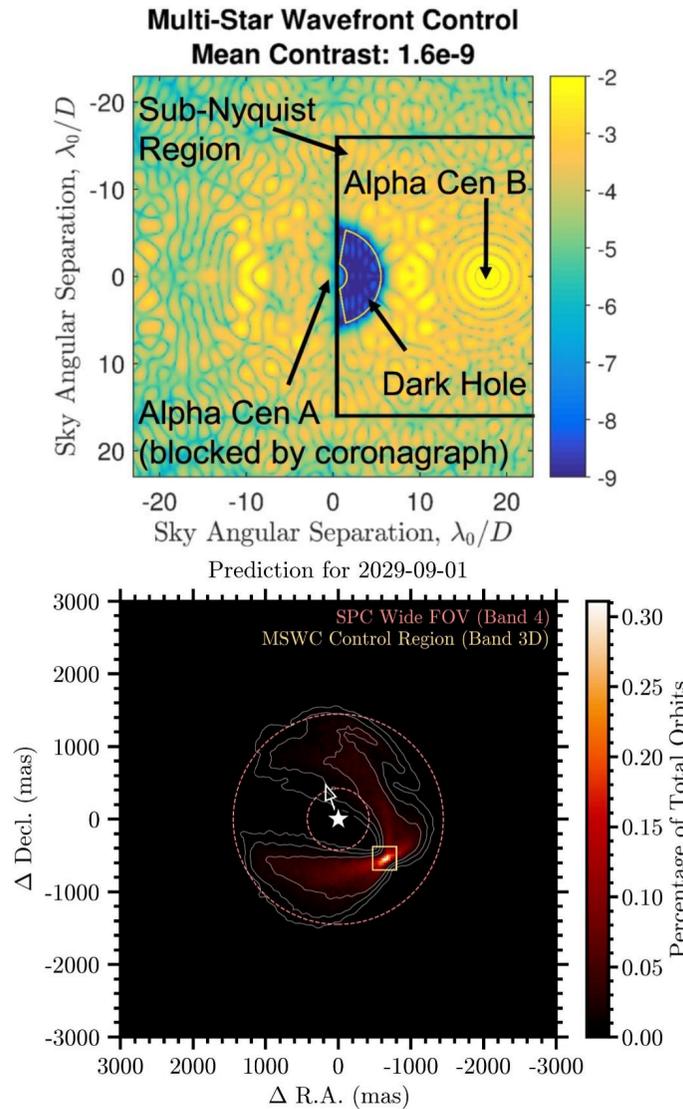


Future Characterization

MSWC - Roman/CGI
Albedo

EELT/METIS
IR Spectrum

TOLIMAN
Dynamical Mass



Quanz EPSC (2015)

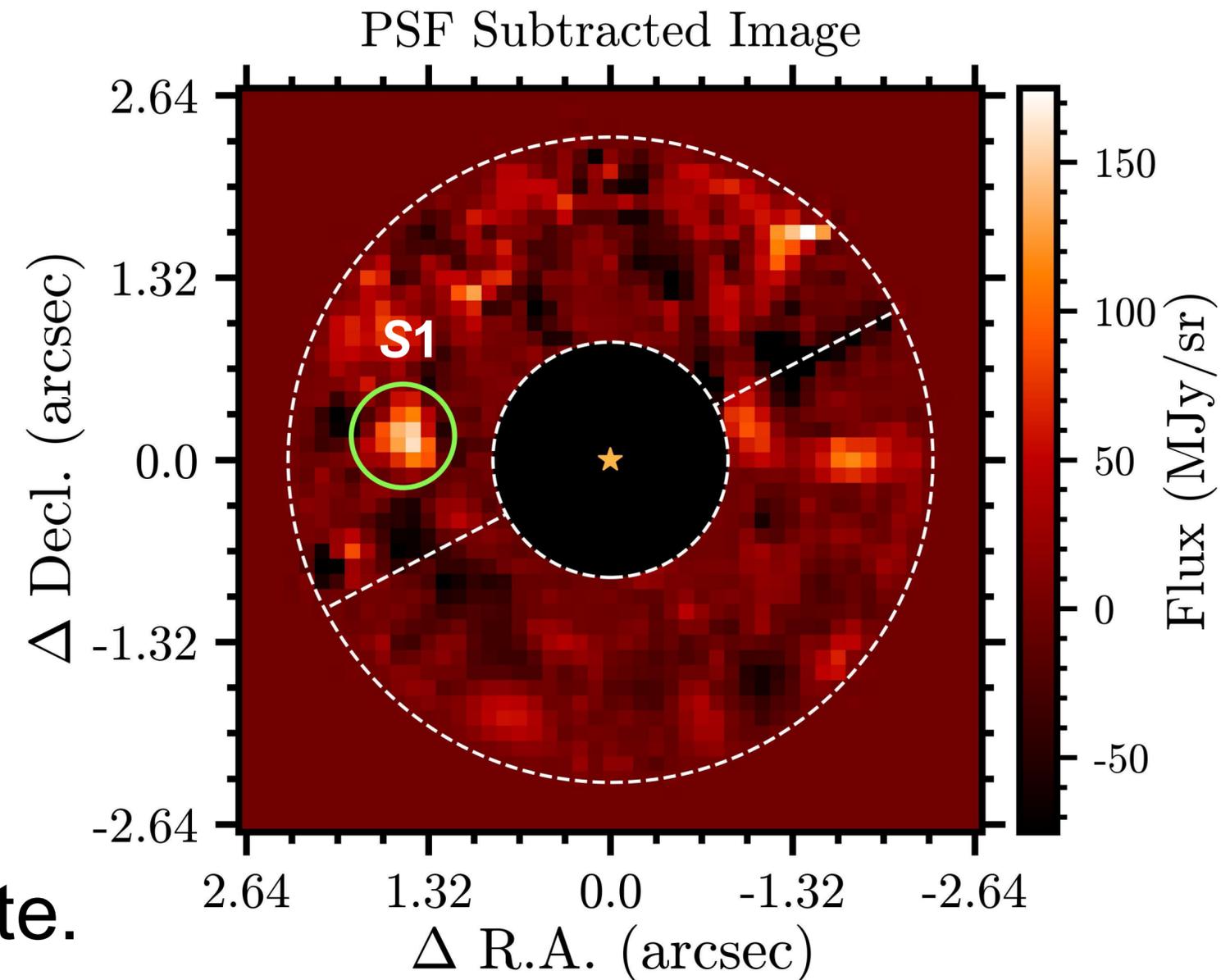
Tuthill et al. (2024)

Sirbu et al. 2017
Bendek et al. (incl. Sanghi) CPP White Paper

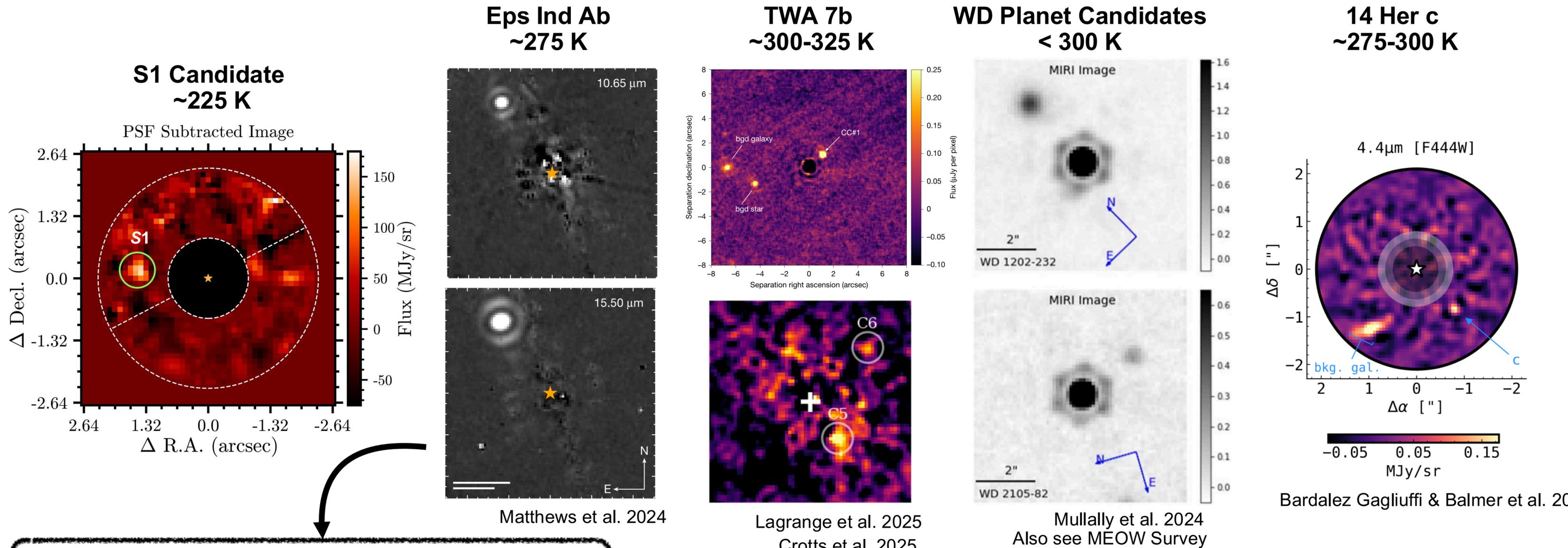
Pushing the boundaries - - ->

Confirmation of **S1** as “ α Cen Ab” would make it the

- ★ nearest (1.33 pc),
- ★ coldest (~ 225 K),
- ★ oldest (~ 5 Gyr),
- ★ shortest period (~ 2 yr),
- ★ lowest mass ($< 200 M_{\oplus}$) planet imaged orbiting a Sun-like star to date.



A New Population of Imaged Cold Planets



Avatar: Pandora's View of Gas Giant Polyphemus in the HZ of a Cen A



A conversation with James Cameron!

JWST's Candidate Gas Giant



Paper I: Beichman & Sanghi et al. 2025 (ApJL)
Paper II: Sanghi & Beichman et al. 2025 (ApJL)