THE FEATHERWEIGHT GIANT:

UNRAVELING THE ATMOSPHERE OF A 17 MYR "HOT JUPITER" WITH JWST

Pa Chia Thao [1], Andrew Mann,[1] Adina Feinstein[2], Peter Gao[3], Daniel Thorngren[4], et al.

[1] University of North Carolina at Chapel Hill; [2] University of Colorado at Boulder; [3] Carnegie Institute for Science EPL; [4] Johns Hopkins University

: pachia@live.unc.edu

Characterizing the atmospheres of young (<1 Gyr) planets is vital to understanding planetary formation and migration history, as it allows us to directly investigate their initial conditions.

However, obtaining the masses of young planets have been challenging.

HIP 67522 b is a 17 Myr gas giant that orbits a G-dwarf in the Sco-Cen OB Association [1]. With a R~10 $R_\oplus$ and a P~7 d, the planet falls within the nominal definition of a hot Jupiter.

Old Planets *vs.* Young Planets

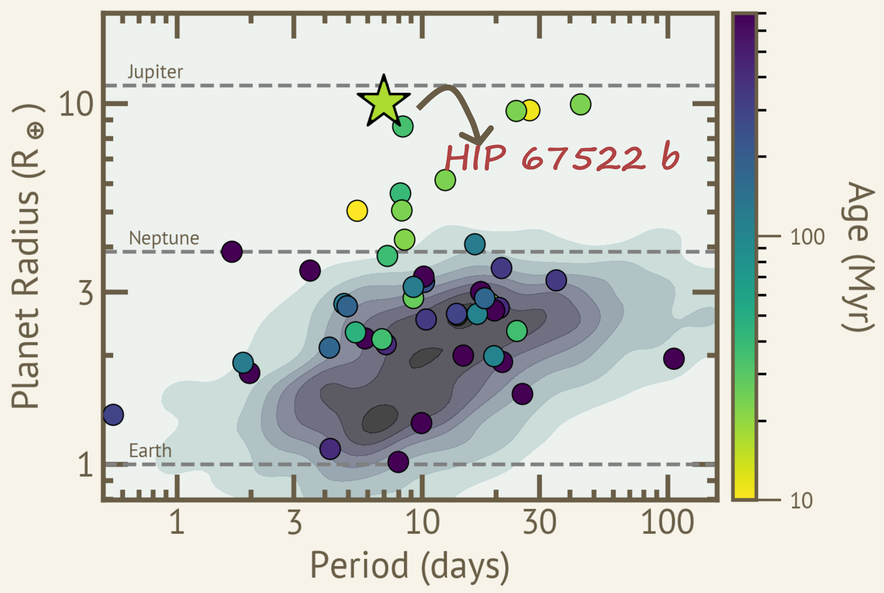
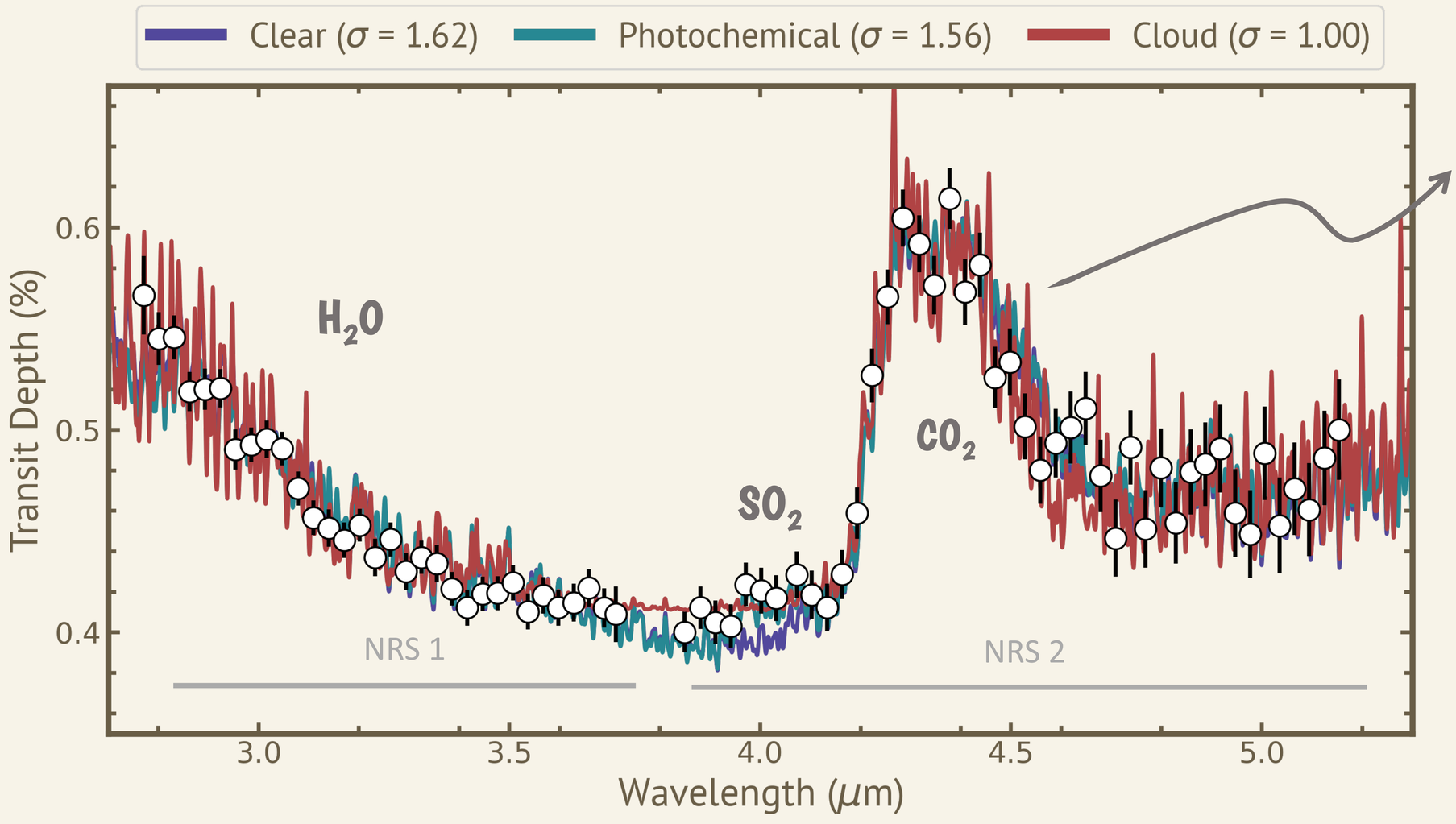


Fig 1. (*Right*) Observed population of planets from *Kepler* [2]. Young planets (circles) are color coded by their age.

GOAL

To characterize the atmosphere of the *17 Myr,* gas giant, **HIP 67522 b** using JWST/NIRSpec/G395H



The transmission spectrum exhibits absorption features that are 30-50% deeper than the baseline!

The strength of the molecular feature (ΔD) is proportional to the atmospheric scale height (H) [3]:

$$\Delta D \sim H \propto \frac{1}{\mu g}$$

(mean molecular weight) (surface gravity)

Using the strength of the molecular feature, we get a mass estimate of HIP 67522 b to be ~15 $M_\oplus$

ATMOPSHERIC MODELS

CLEAR : We used PICASO [4] to generate the clear-sky atmospheric models, ranging metallicity from 1-100 x Solar metallicity, C/O values from 0.25-2 x Solar, and masses from 8-50$M_\oplus$. The data prefer models with planet masses ~15-20 $M_\oplus$, super solar metallicities, and C/O < 2 x Solar. All other models are ruled out by 5σ.

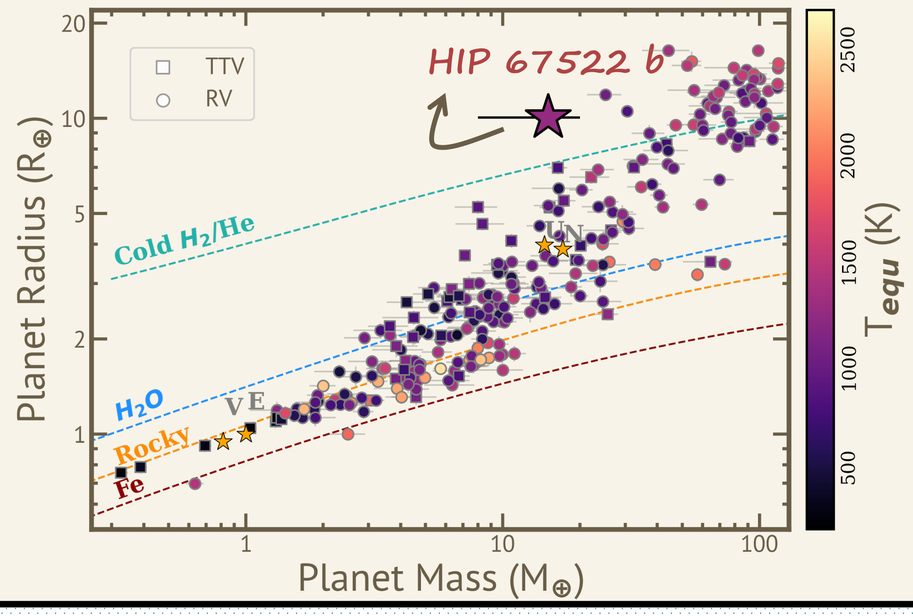
CLOUD : Clouds weaken the features and hence require a lower mass (8-10$M_\oplus$) to reproduce the feature strength

PHOTOCHEMICAL: Accounting for photochemistry using VULCAN [5] tightens the constraints on the atmospheric composition as the observation prefers a sub-solar metallicity.

SPOTS?

Two occulted spot crossings were observed; however, stellar surface inhomogeneities cannot replicate the strength of the CO_2 feature for any reasonable spot temperatures.

Thus, spots have negligible impact on our interpretation of the transmission spectrum



- We detected H_2O (140σ), CO_2 (130σ), and SO_2 (5σ)
- The atmospheric metallicity of HIP 67522 b is in the range of 3-100 x Solar with C/O ratio between 0 and 1
- We constrained HIP 67522b's mass to be <20 $M_\oplus$ irrespective of cloud cover or contamination from the host star – challenging the previous classification of the planet as a hot Jupiter and positions it as a precursor to a sub-Neptune
- With a density of <0.10 g/cm^3, HIP 67522 b emerges as one of the lowest density planets among the broader population

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submitted (stay tune!)

References: [1] A. Rizzuto 2020, AJ, 160, 33; [2] A. Dattilo 2023, AJ, 166, 22; [3] K. Stevenson 2016, ApJL, 817.2, L6; [4] N. Batalha 2019, 878, 70; [5] S. Tsai 2017, AJ, 228, 20

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