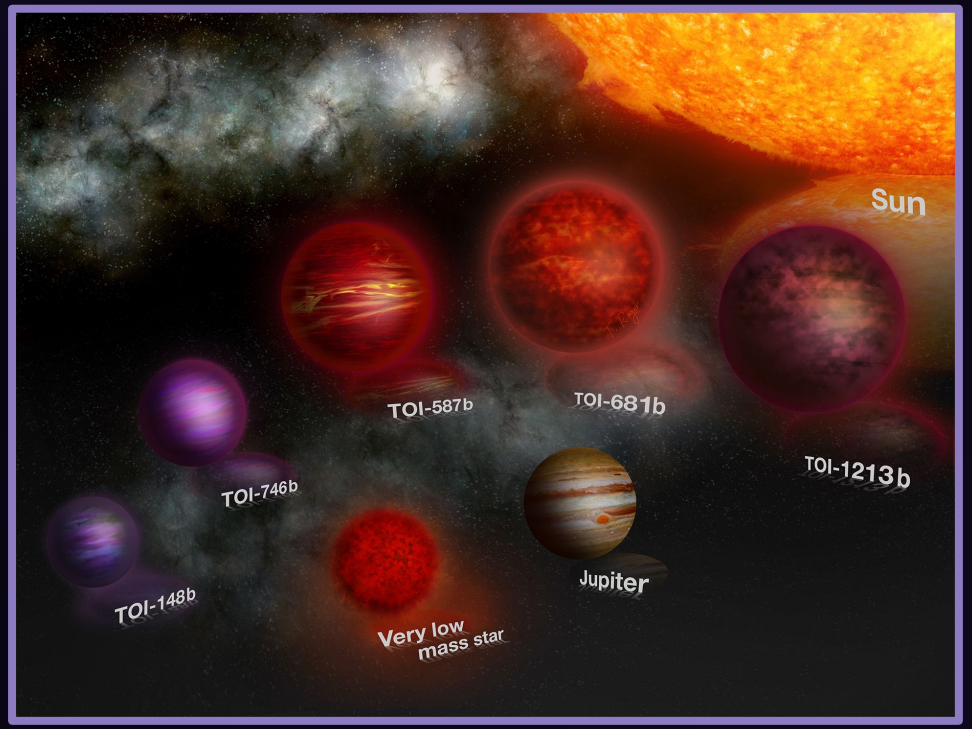
Using Transiting Brown Dwarfs to Define the Planetary Mass Limit



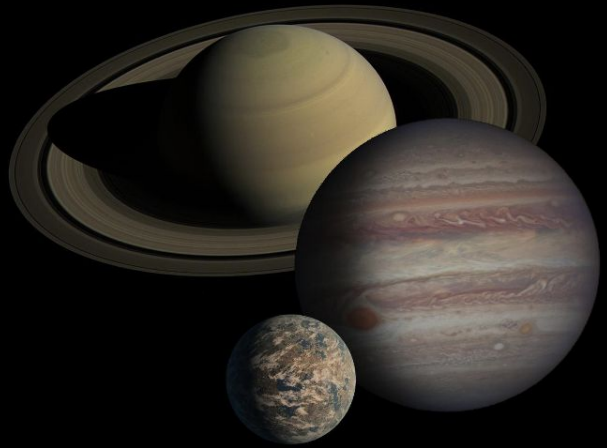
Credit: Thibaut Roger

Noah Vowell
7/29/2024
TSC III

CENTER FOR
ASTROPHYSICS
HARVARD & SMITHSONIAN

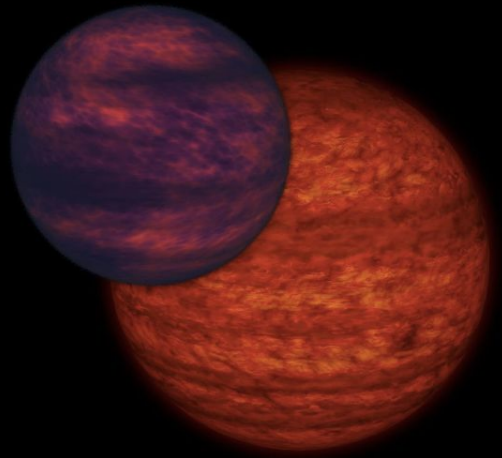
MICHIGAN STATE UNIVERSITY
Founded 1855

Planets & Exoplanets



Up to ~13x
Jupiter's mass

Brown Dwarfs

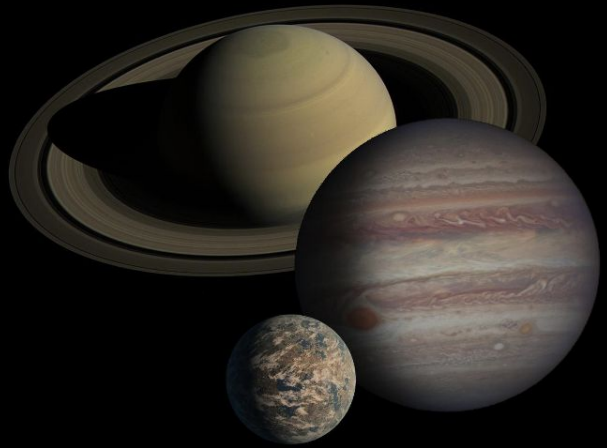


~13x to 80x
Jupiter's mass

Stars
(Fueled by Nuclear Fusion)

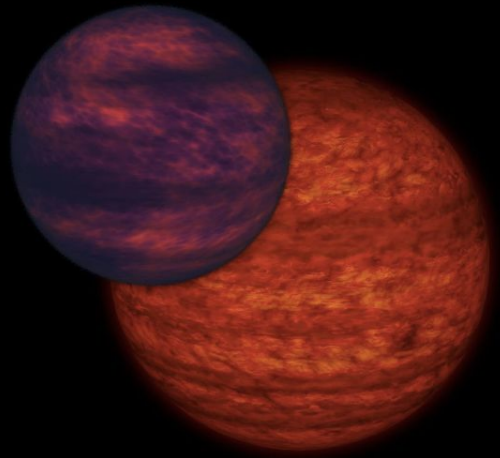
Over ~80x
Jupiter's mass

Planets & Exoplanets



- Form via core accretion in a circumstellar disk

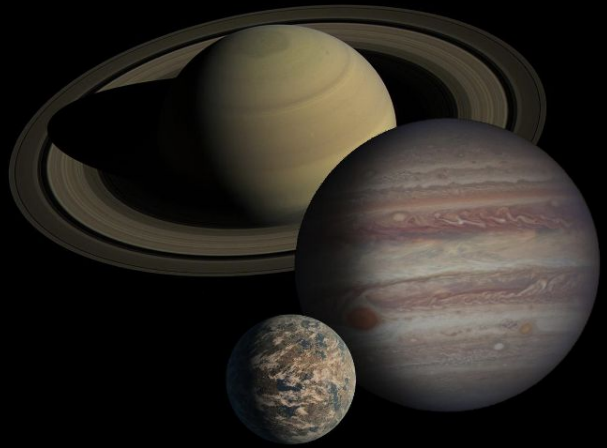
Brown Dwarfs



Stars
(Fueled by Nuclear Fusion)

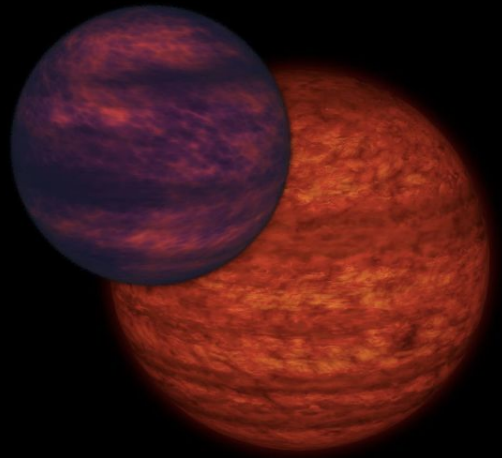
- Form via direct collapse or fragmentation

Planets & Exoplanets



- Form via core accretion in a circumstellar disk

Brown Dwarfs



- Probably a mix of both?

Stars

(Fueled by Nuclear Fusion)

- Form via direct collapse or fragmentation

Some Key Questions:

- How big/small can a planet/star be?
- Can we differentiate between planet and star formation in this regime?
- What new insights does the transiting brown dwarf population provide?

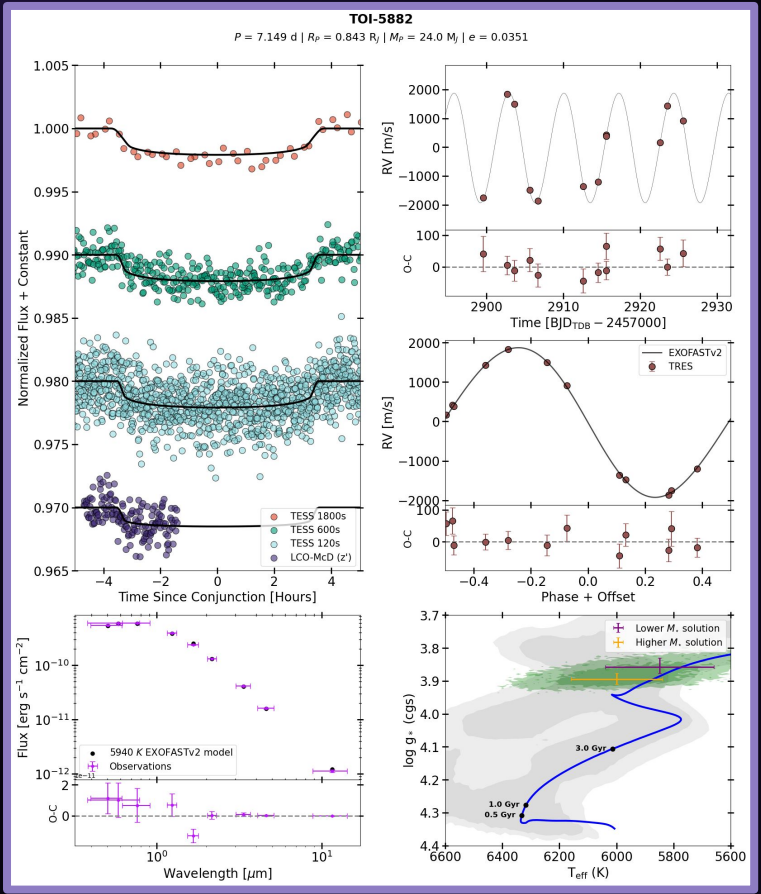
Transiting Brown Dwarfs: A New Perspective

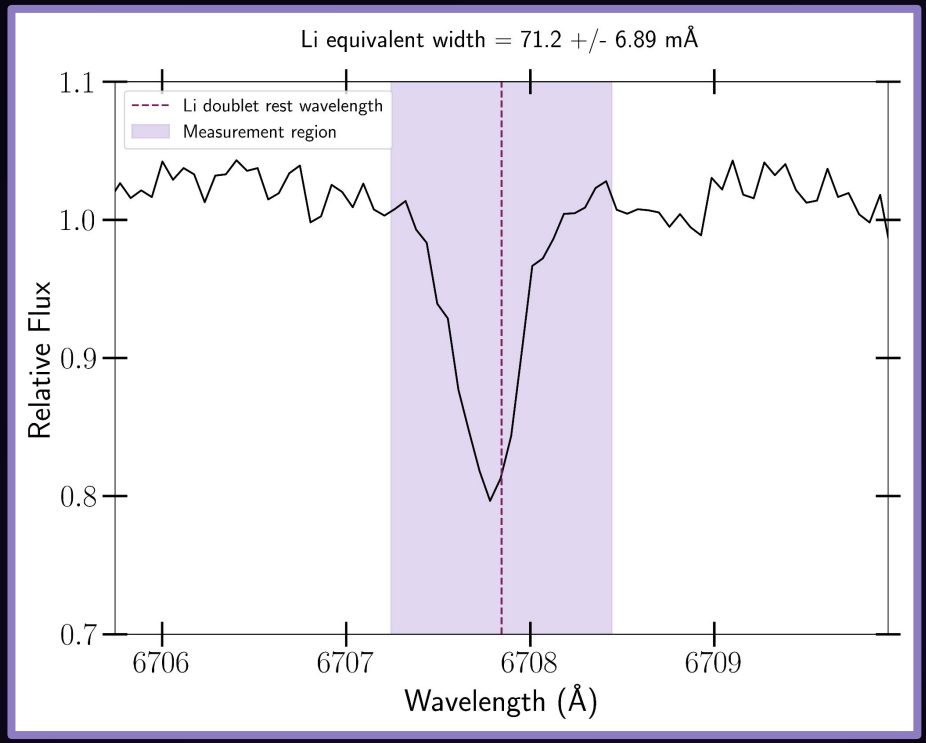
Directly measured mass/radius helps to break the mass-radius-age degeneracy

Now more than 50 transiting brown dwarfs with over 2/3 discovered by the *TESS* mission

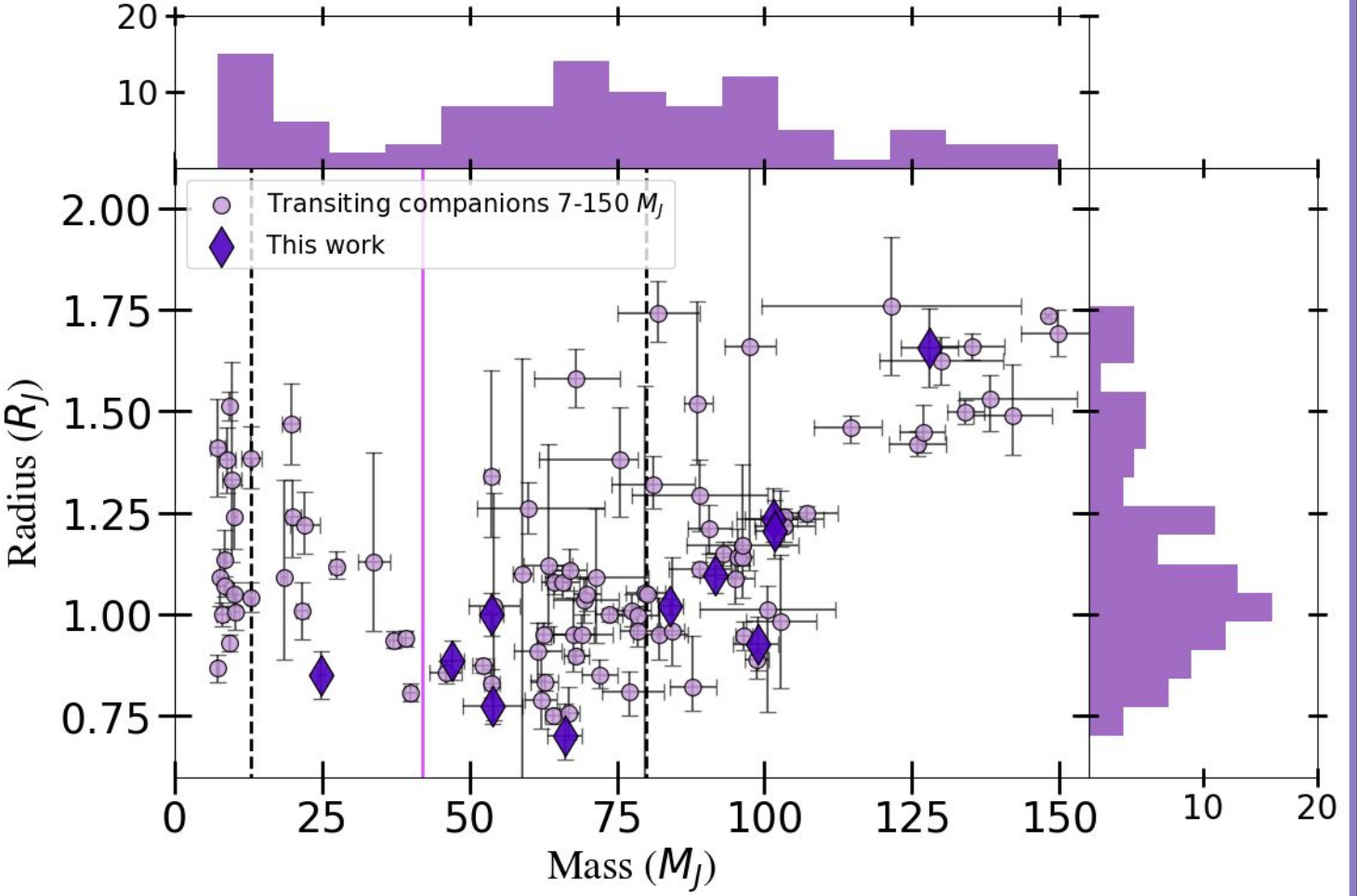
Nearly 15% increase in the population from this work alone

TOI-5882: A planetary engulfment candidate?





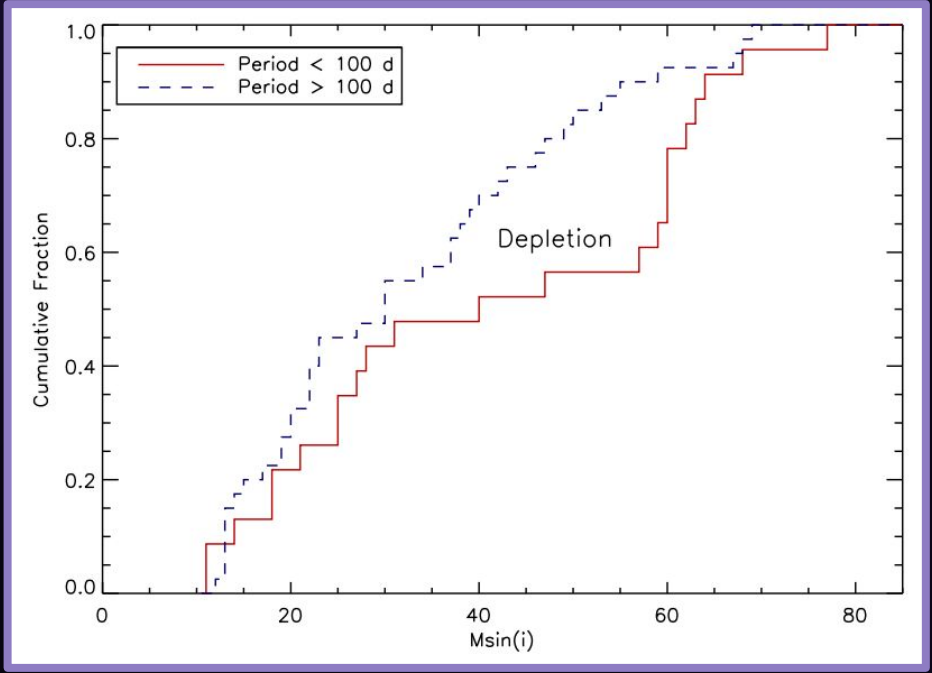
Vowell et al. submitted

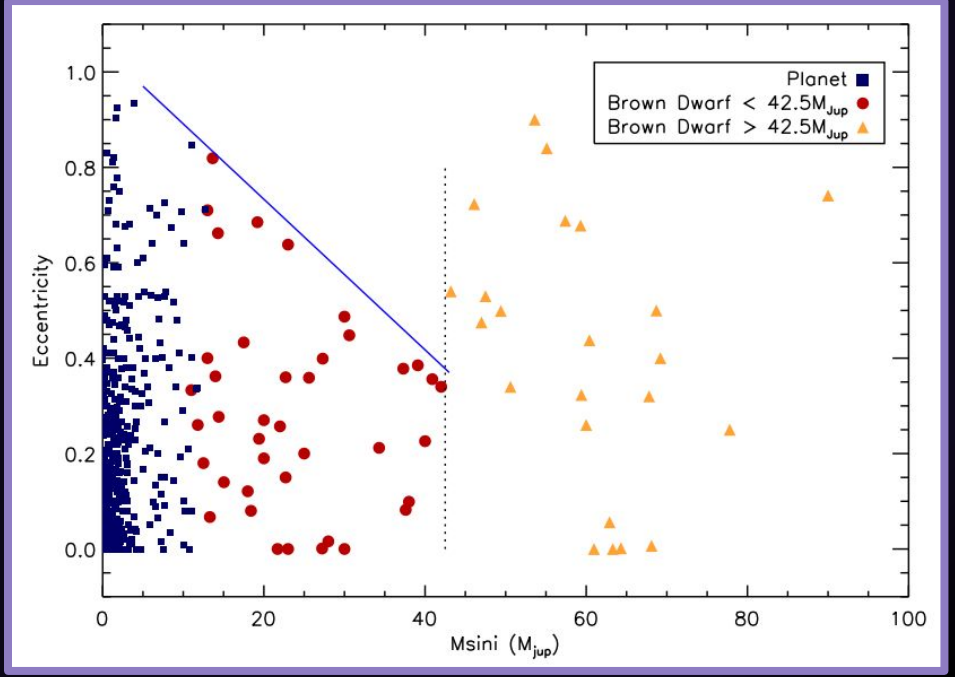


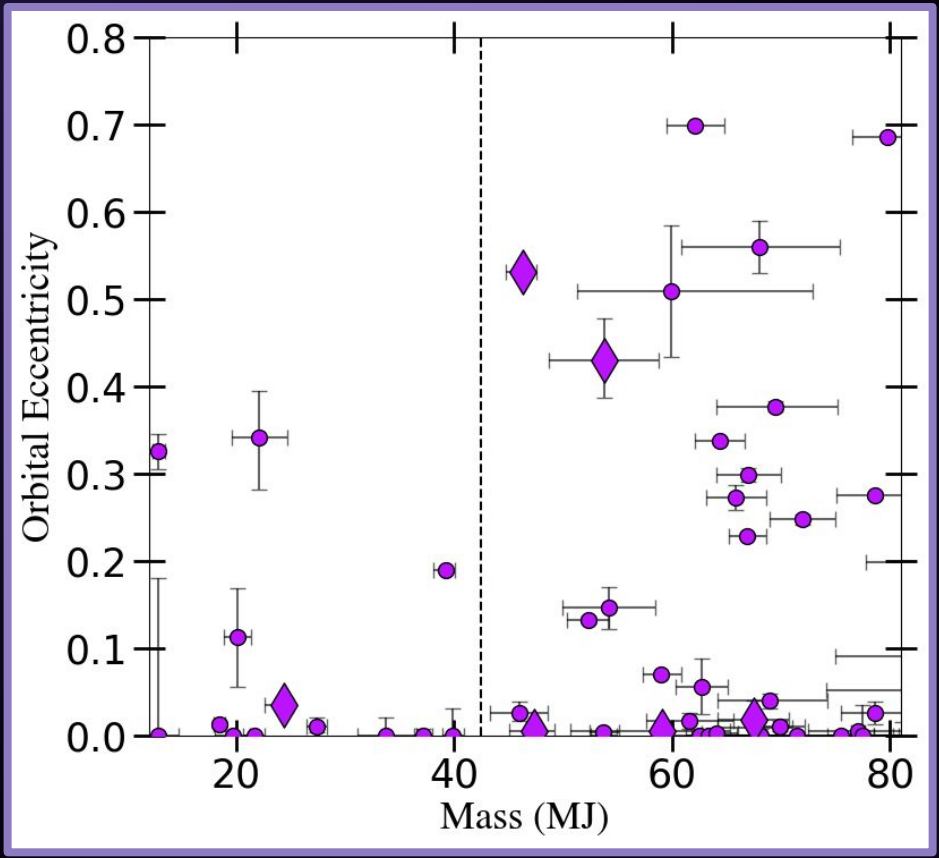
Vowell et al. submitted
And on ArXiV!

Statistical Properties of Brown Dwarf Companions: Implications for Different Formation Mechanisms

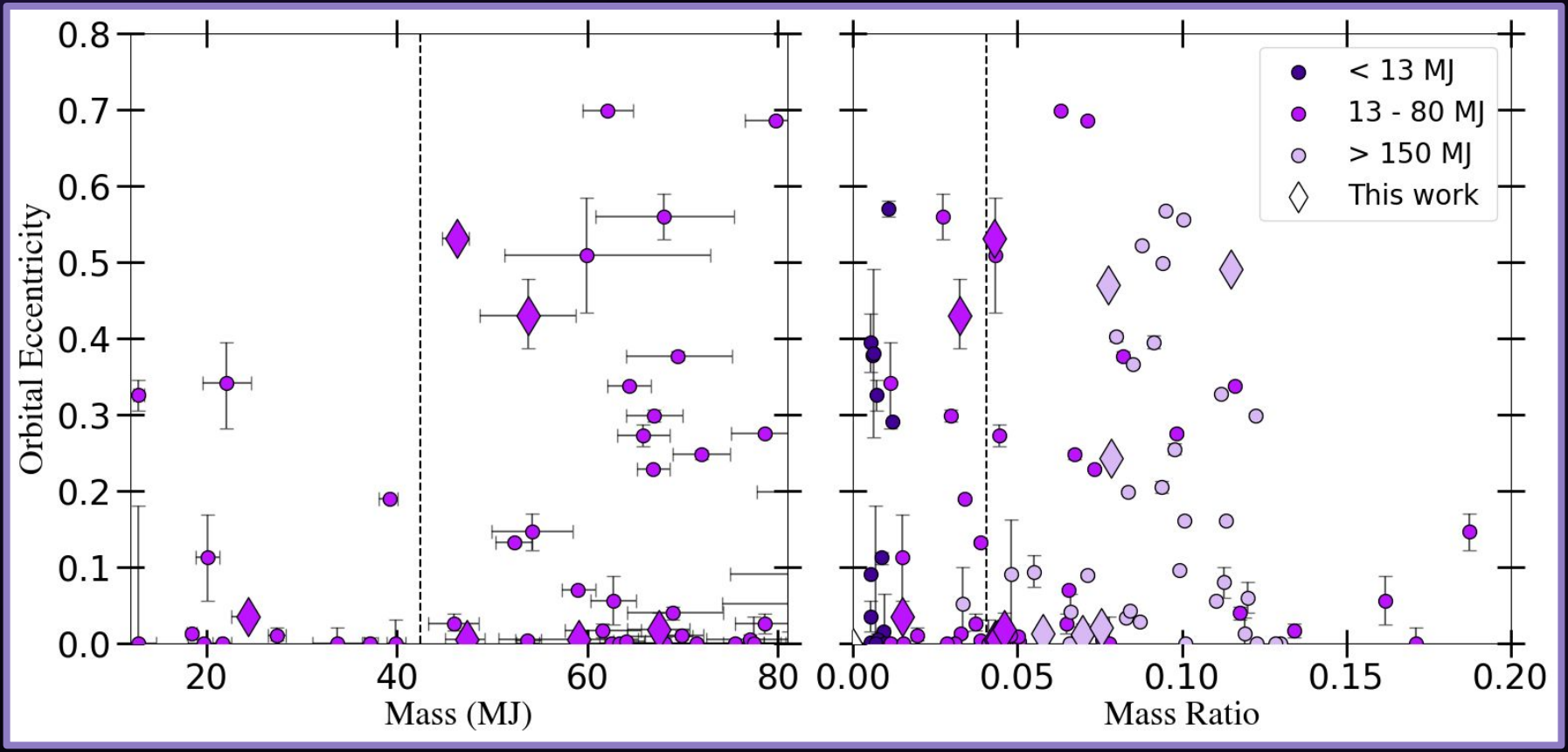
Bo Ma[1⋆] and Jian Ge[1]
[1]*Department of Astronomy, University of Florida, 211 Bryant Space Science Center, Gainesville, FL, 32611-2055, USA*



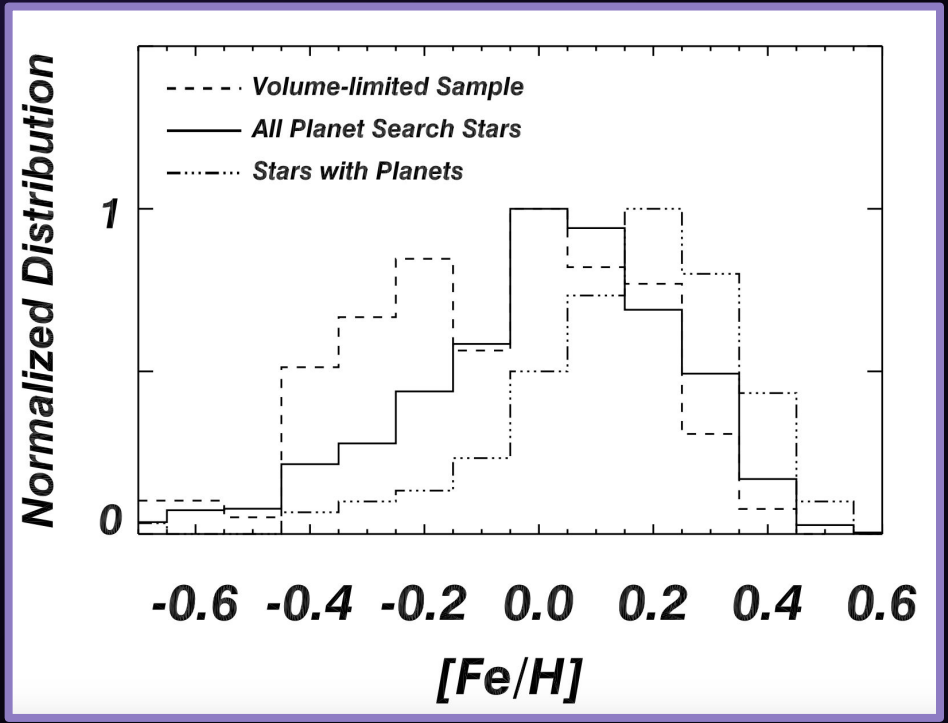




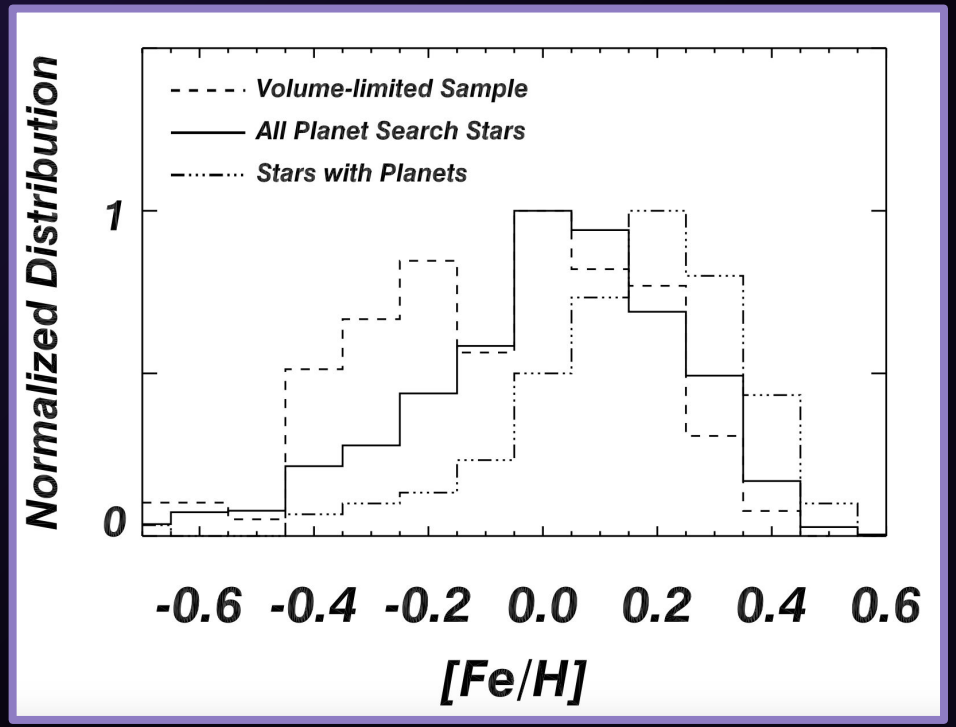
Vowell et al. submitted



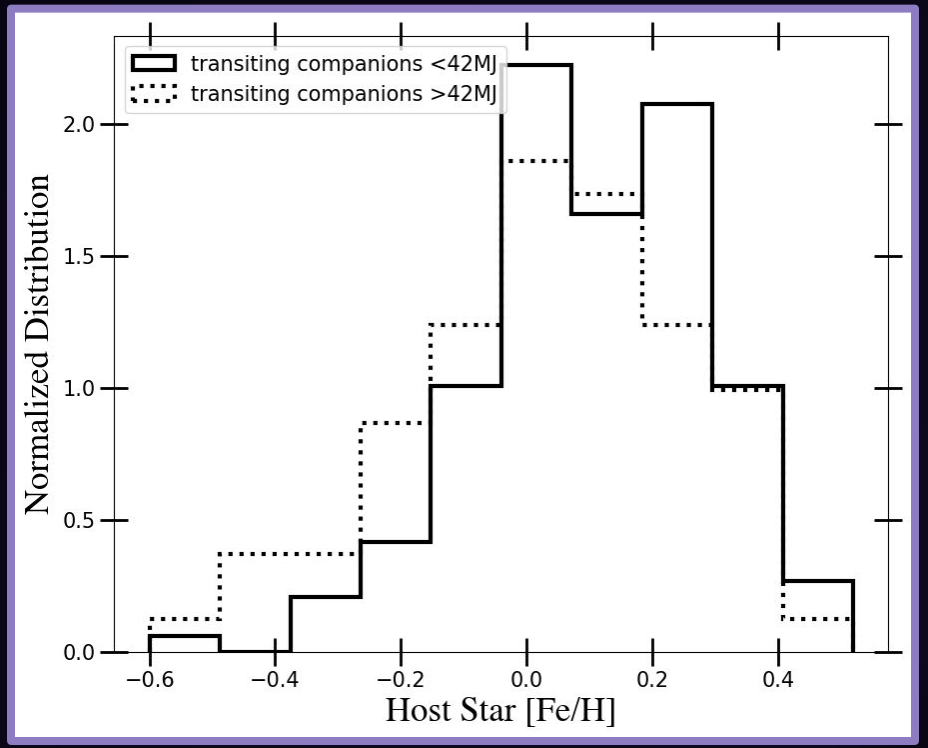
Vowell et al. submitted



Fischer and Valenti 2005

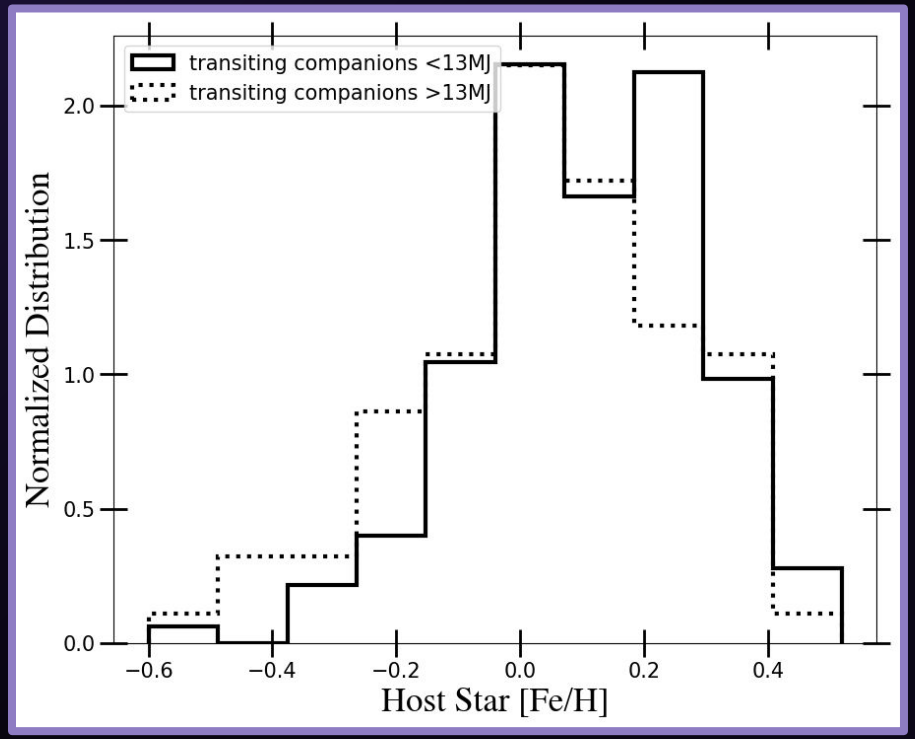


Fischer and Valenti 2005

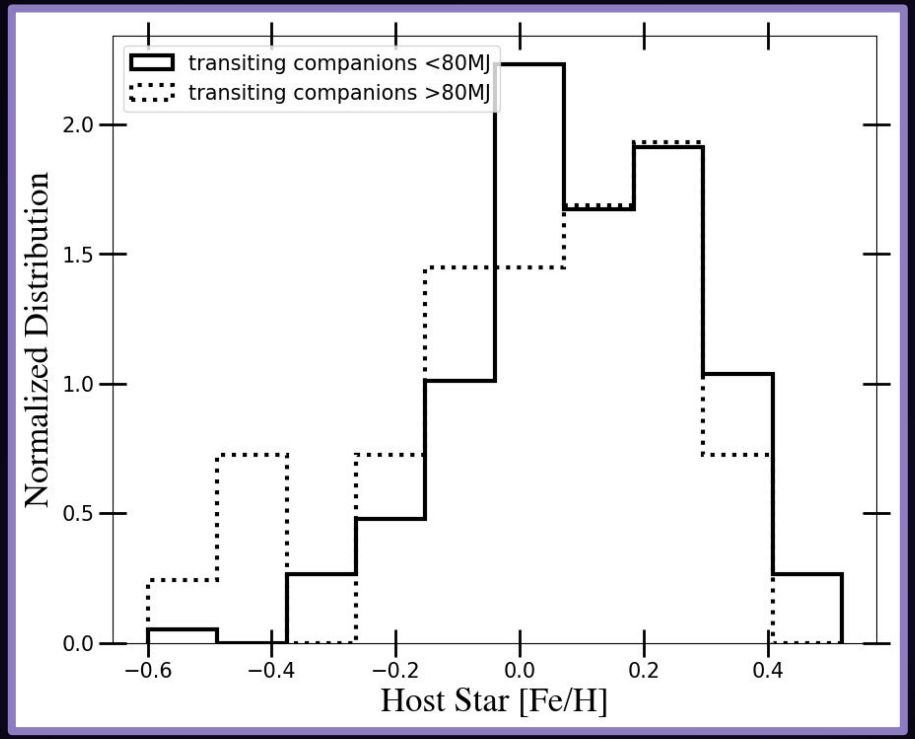


Vowell et al. submitted

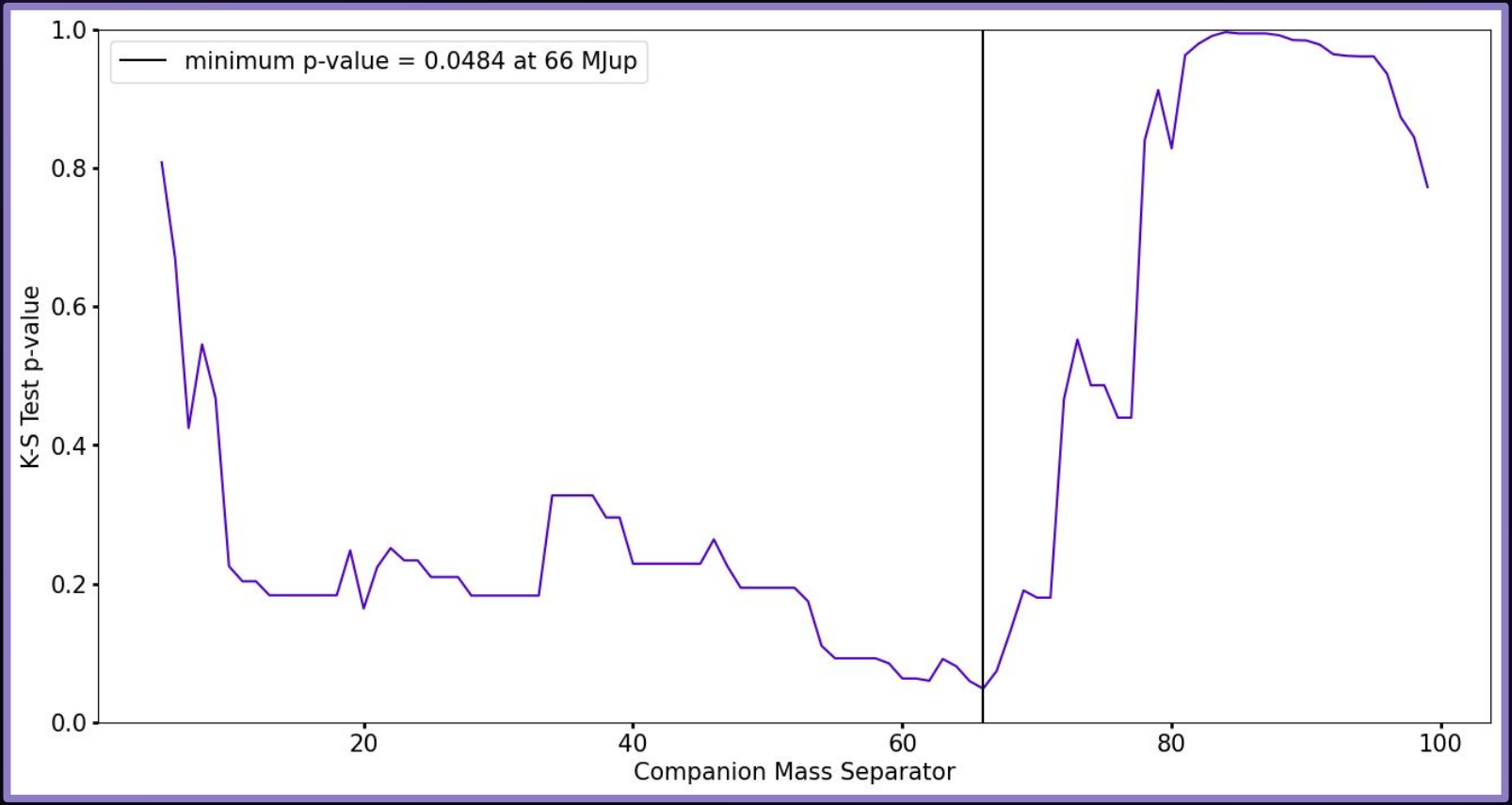
Deuterium Fusion Boundary

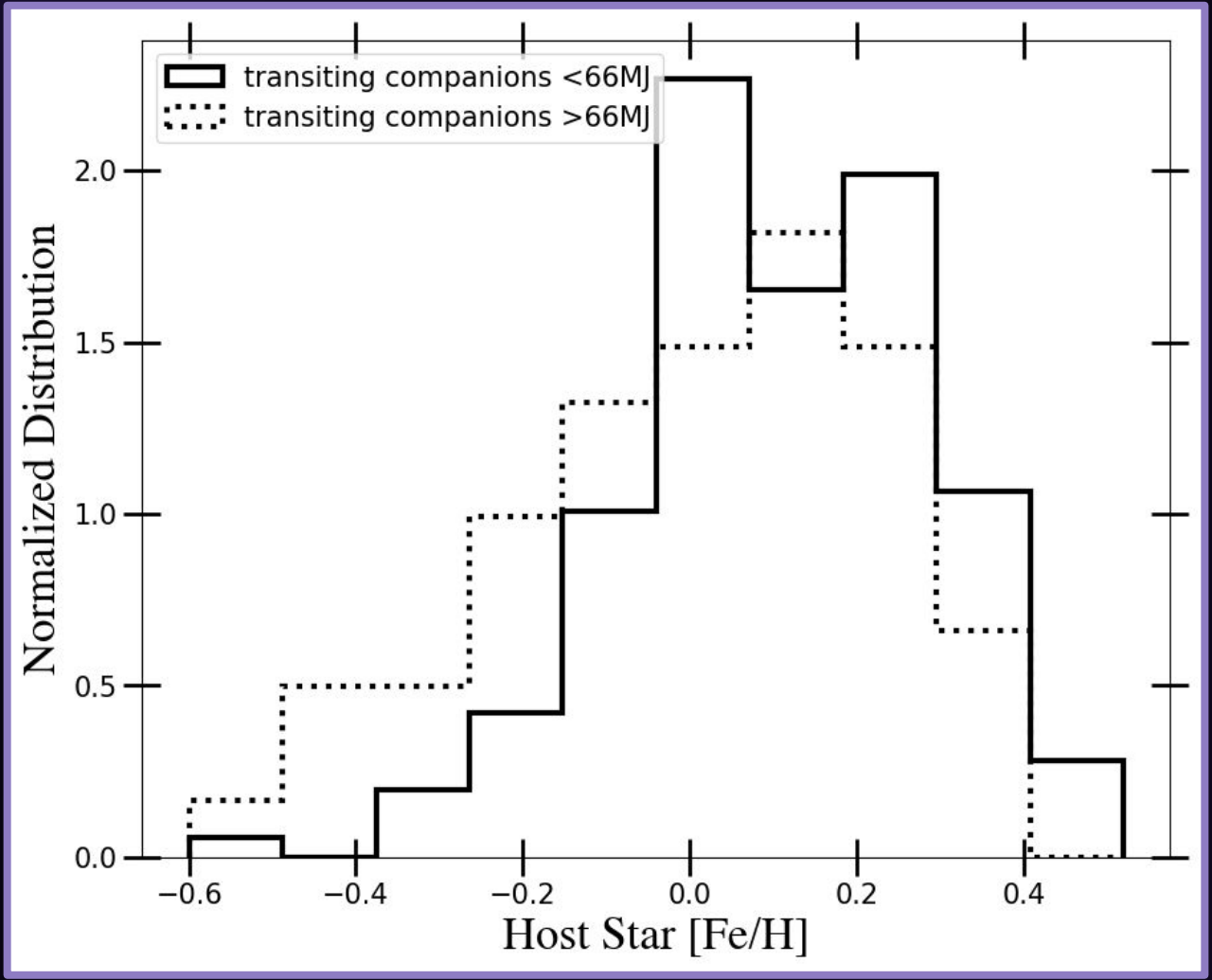


Hydrogen Fusion Boundary



2 Sample KS-Test p-values of host star metallicities




transiting companions <66MJ
transiting companions >66MJ
Normalized Distribution
0.0
0.5
1.0
1.5
2.0
−0.6
−0.4
−0.2
0.0
0.2
0.4
Host Star [Fe/H]

Final thoughts

TESS continues to churn out new transiting brown dwarfs

No clear evidence supporting a 42 M_J transition in eccentricity or metallicity distributions

Metallicity might be promising in distinguishing sub populations

Check out the paper on ArXiV!