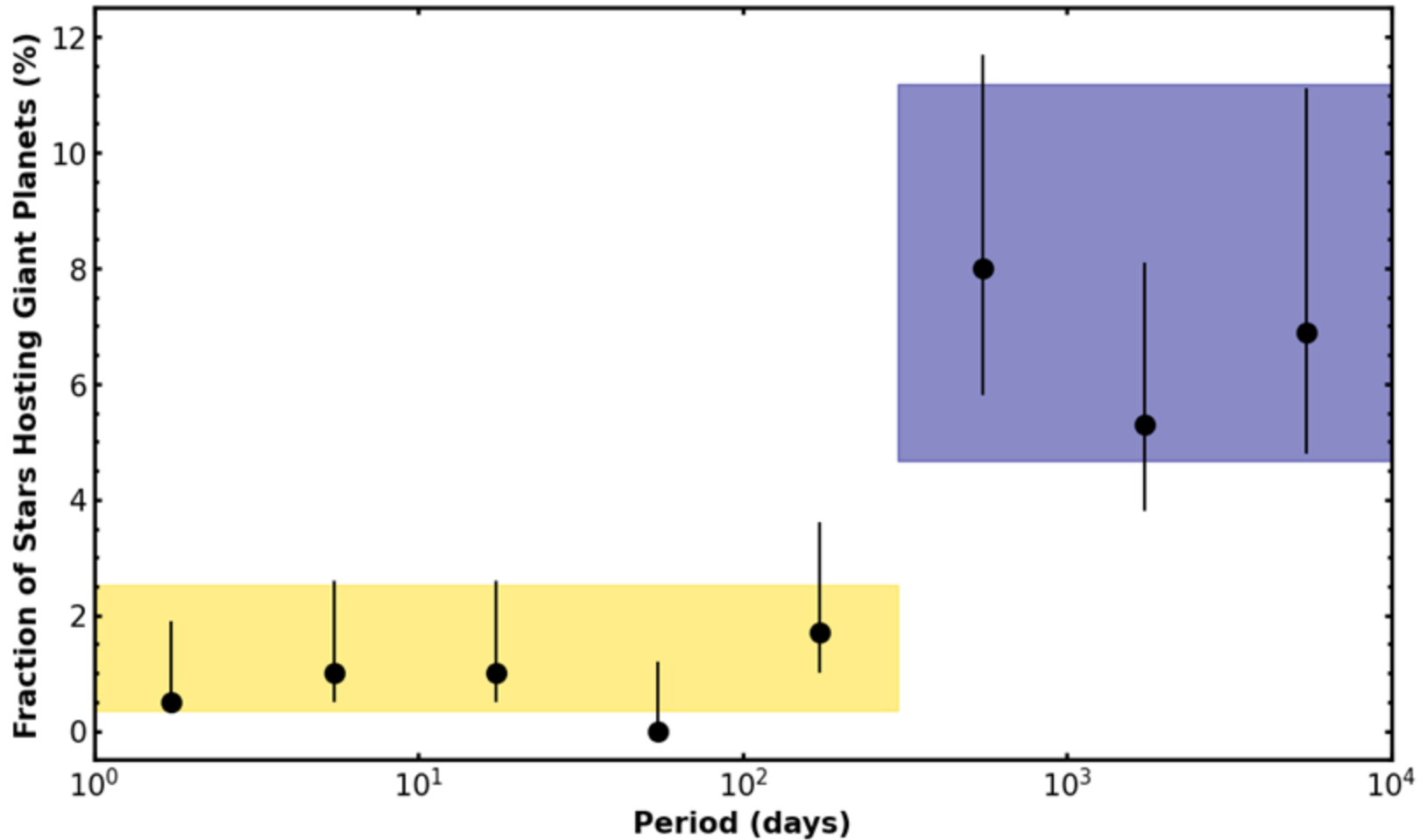


Hot Jupiters are Dynamically Hot

Hot Jupiters around Hot Stars are Dynamically Hotter

Cold Jupiter is x10 times more common

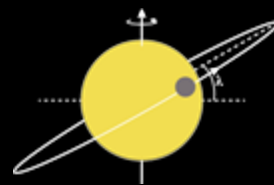


Hot Jupiters are Dynamically Hot

Hot Jupiters around Hot Stars are Dynamically Hotter



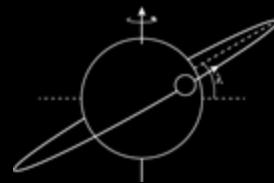
Nearby Companions



Stellar Obliquity



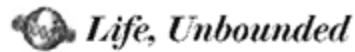
Nearby Companions



Stellar Obliquity

Celebrate Math Awareness Month

Shop Now



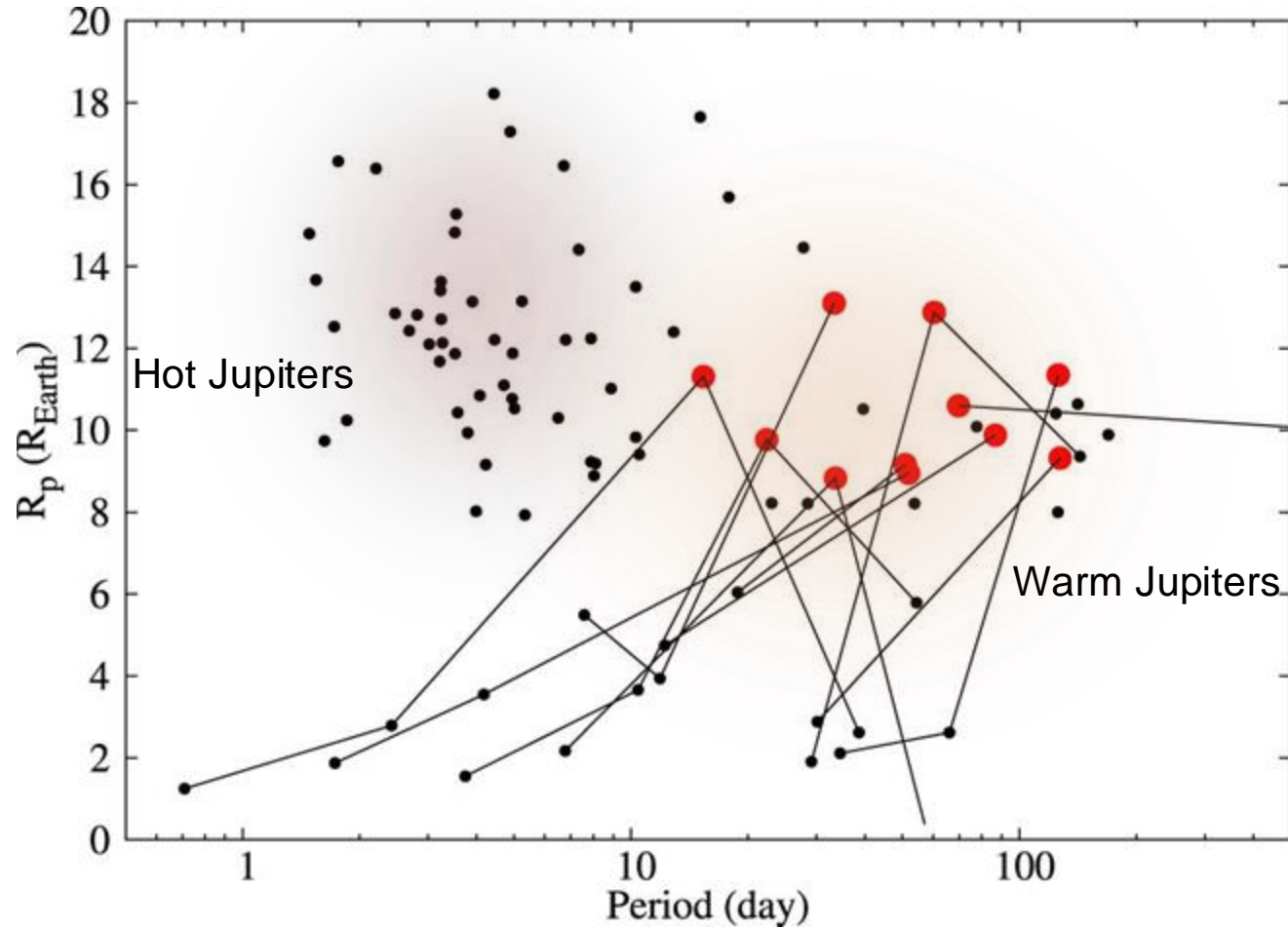
Lonely Planets: Hot Jupiters Are Isolated

By Caleb A. Scharf on May 7, 2012

Hot Jupiters are special beasts in the exoplanetary menagerie. These giant worlds orbit their parent stars incredibly tightly, sometimes zipping around in barely a day or two, and so close that they can disturb the stellar atmosphere itself - as well as throwing themselves at the mercy of gravitational tides and scorching radiation.

They were also the very first type of exoplanets to be

Confirmation of Hot Jupiters' Isolation



First Exceptions

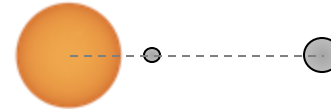


Wasp-47



Becker et al. 2015

Kepler-730



Zhu et al. 2018
Canas, **Wang S.** et al. 2018

Tess Survey: Hot Jupiters Are Still Lonely

A Uniform Search for Nearby Planetary Companions to Hot Jupiters in TESS Data Reveals Hot Jupiters Are Still Lonely

Benjamin J. Hord^{1,2,3} , Knicole D. Colón^{2,3} , Veselin Kostov^{2,3} ,
Brianna Galgano^{2,4} , George R. Ricker⁵ , Roland Vanderspek⁵ ,
S. Seager^{5,6,7} , Joshua N. Winn⁸ , Jon M. Jenkins⁹ , Thomas Barclay^{2,10} 

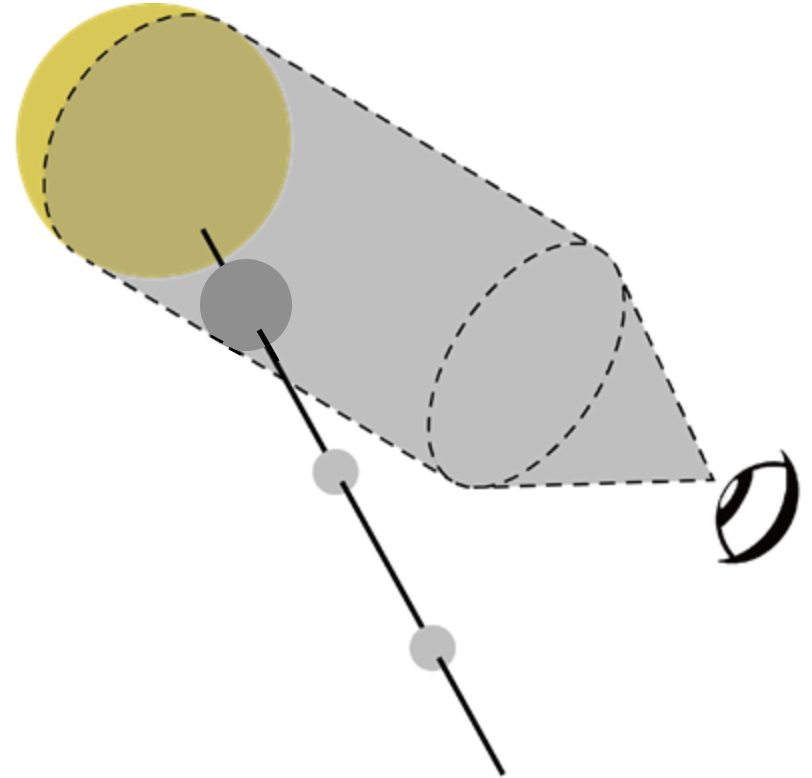
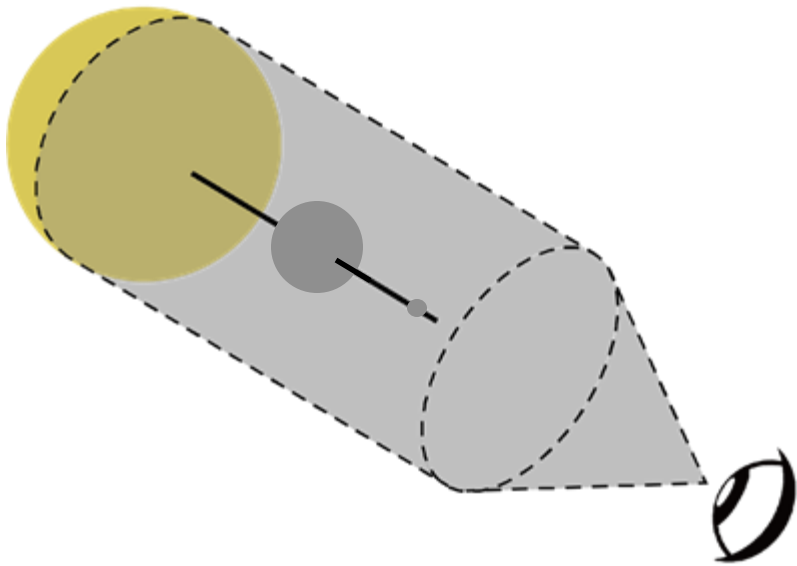
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[The Astronomical Journal](#), [Volume 162](#), [Number 6](#)

Citation Benjamin J. Hord *et al* 2021 *AJ* **162** 263

Limitation: small or non-transiting companions



Limitation for Previous TTV Search



No TTVs are Detected for hot Jupiters

Q1-6

Steffen et al. 2012

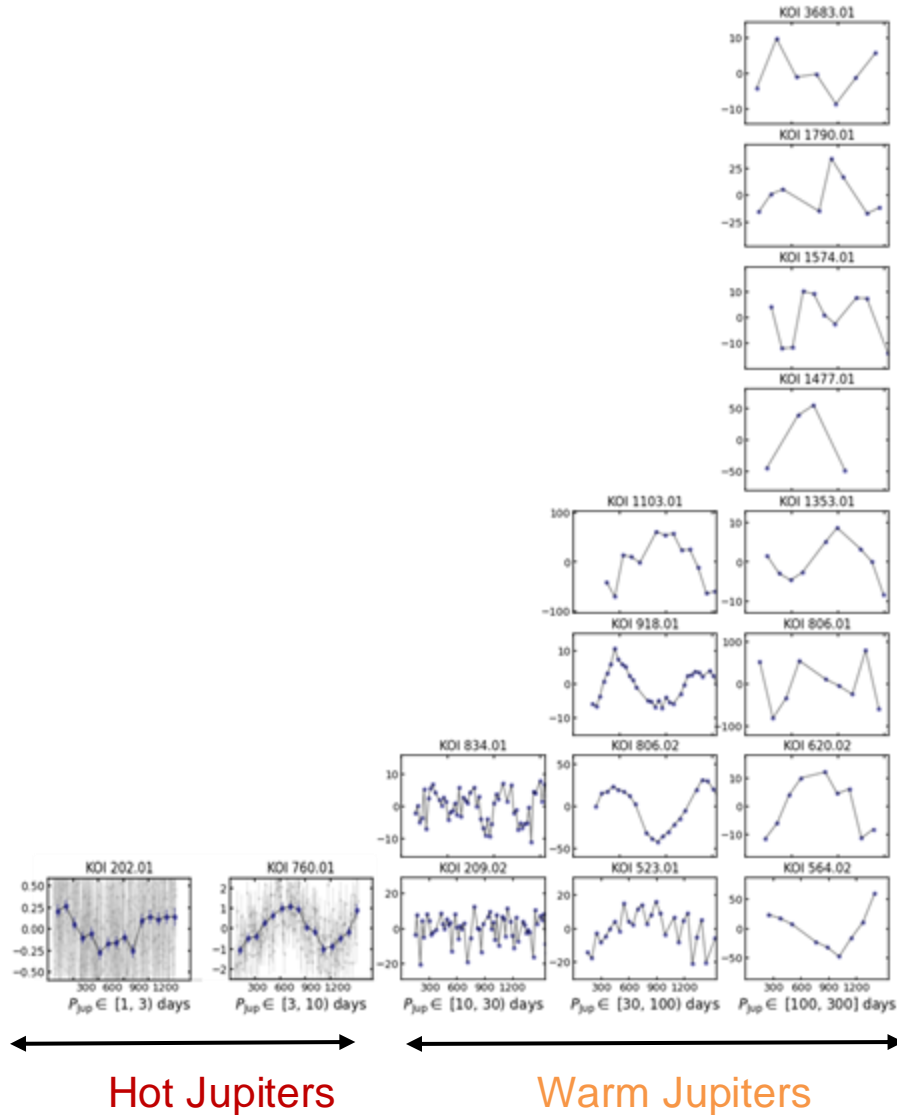


Two TTVs are Detected for hot Jupiters

Q1-17

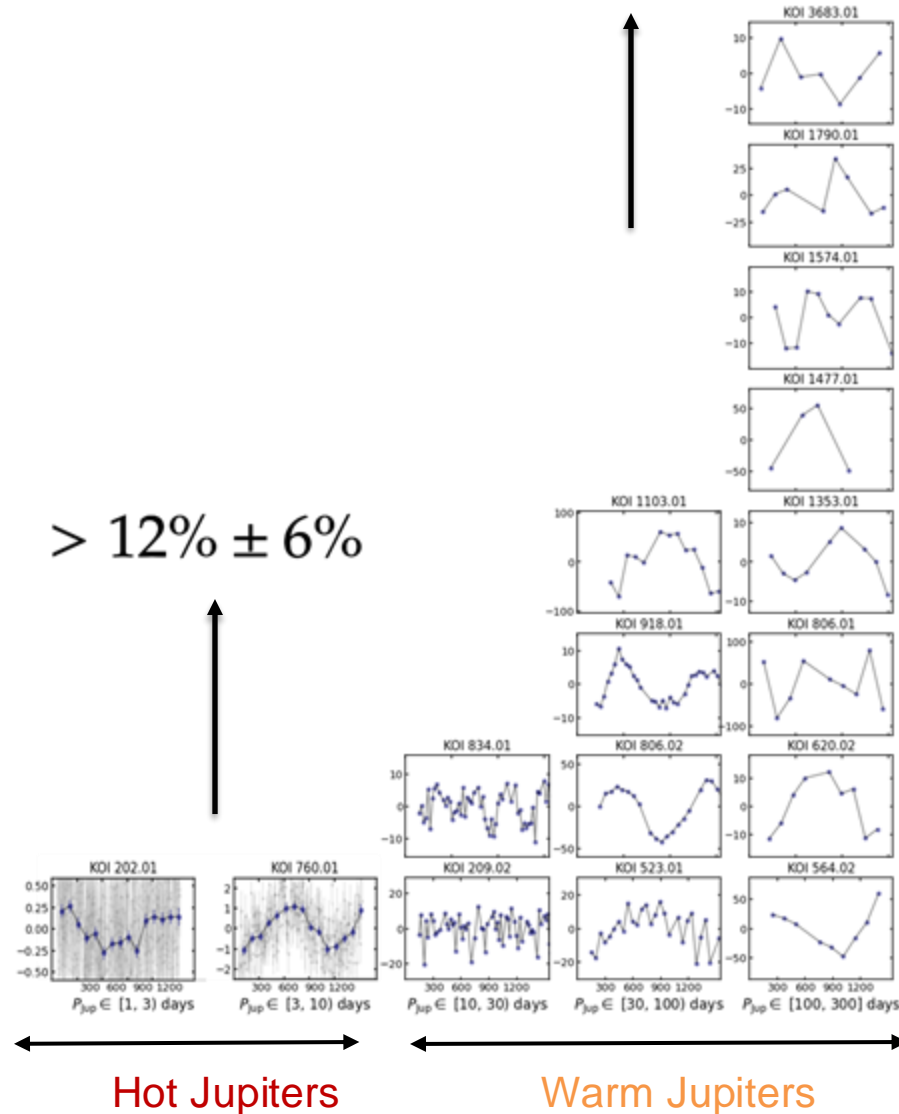
This work

16 Validated Detections

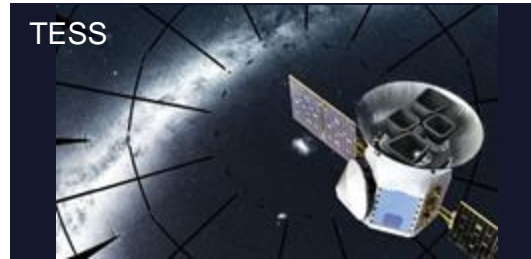


16 Validated Detections

$> 70\% \pm 16\%$



TESS is Detecting them!



TOI-1130				Huang et al. 2020
WASP-132				Hord et al. 2022
WASP-84				Maciejewski et al. 2023
TOI-2494				Rodriguez et al. 2024
TOI-5143				Quinn et al. 2025

Our New Perspective

Hot Jupiters are not as lonely as we thought

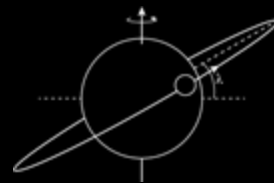
Our New Perspective

Hot Jupiters are not as lonely as we thought

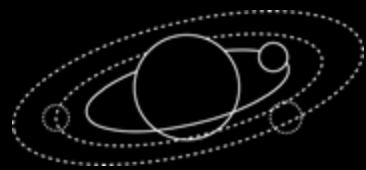
Still far more isolated than Warm Jupiters



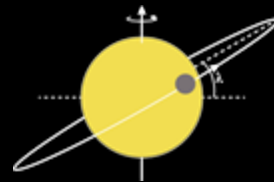
Nearby Companions



Stellar Obliquity

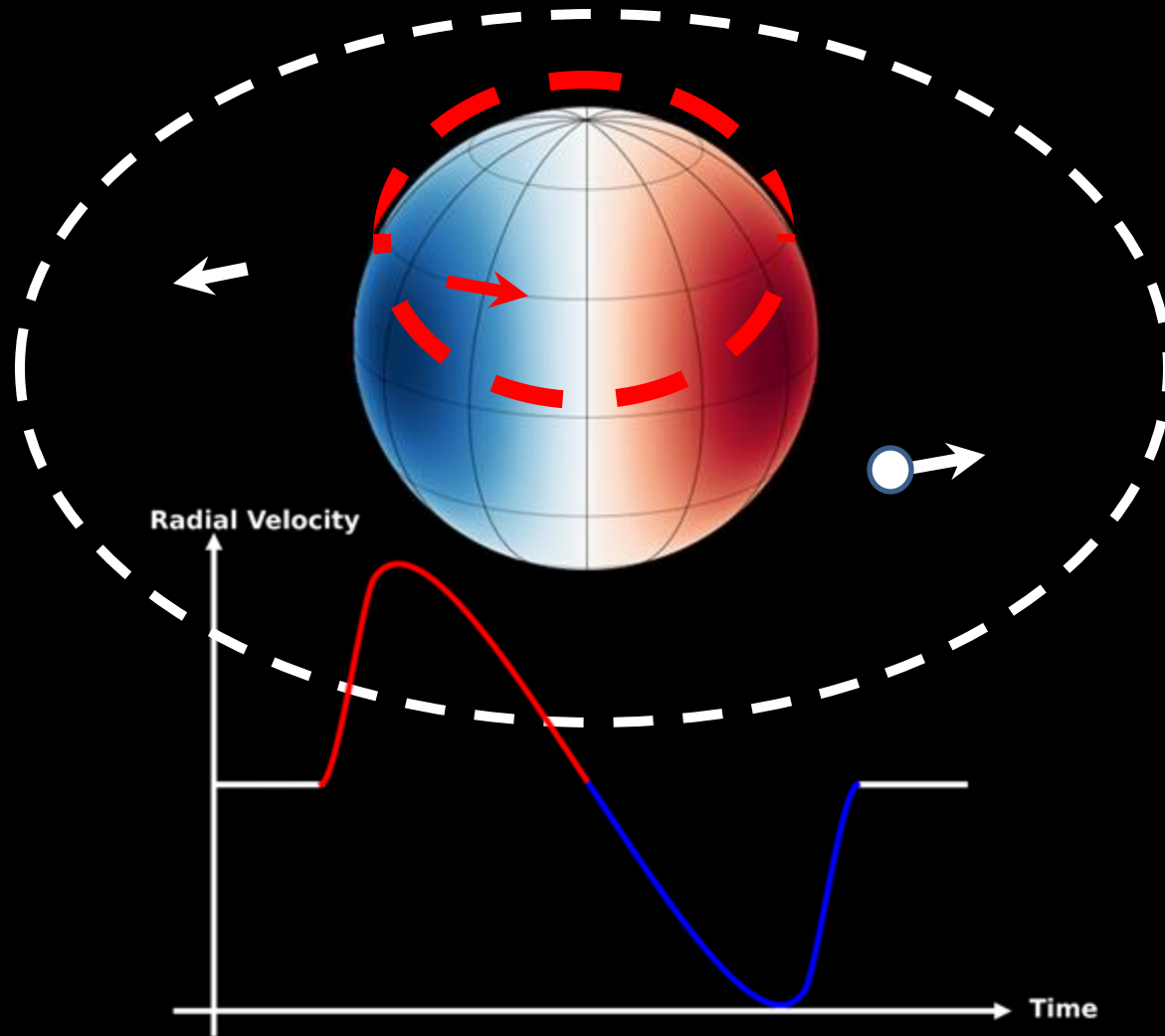


Nearby Companions



Stellar Obliquity

100 Year Anniversary of R-M Effect

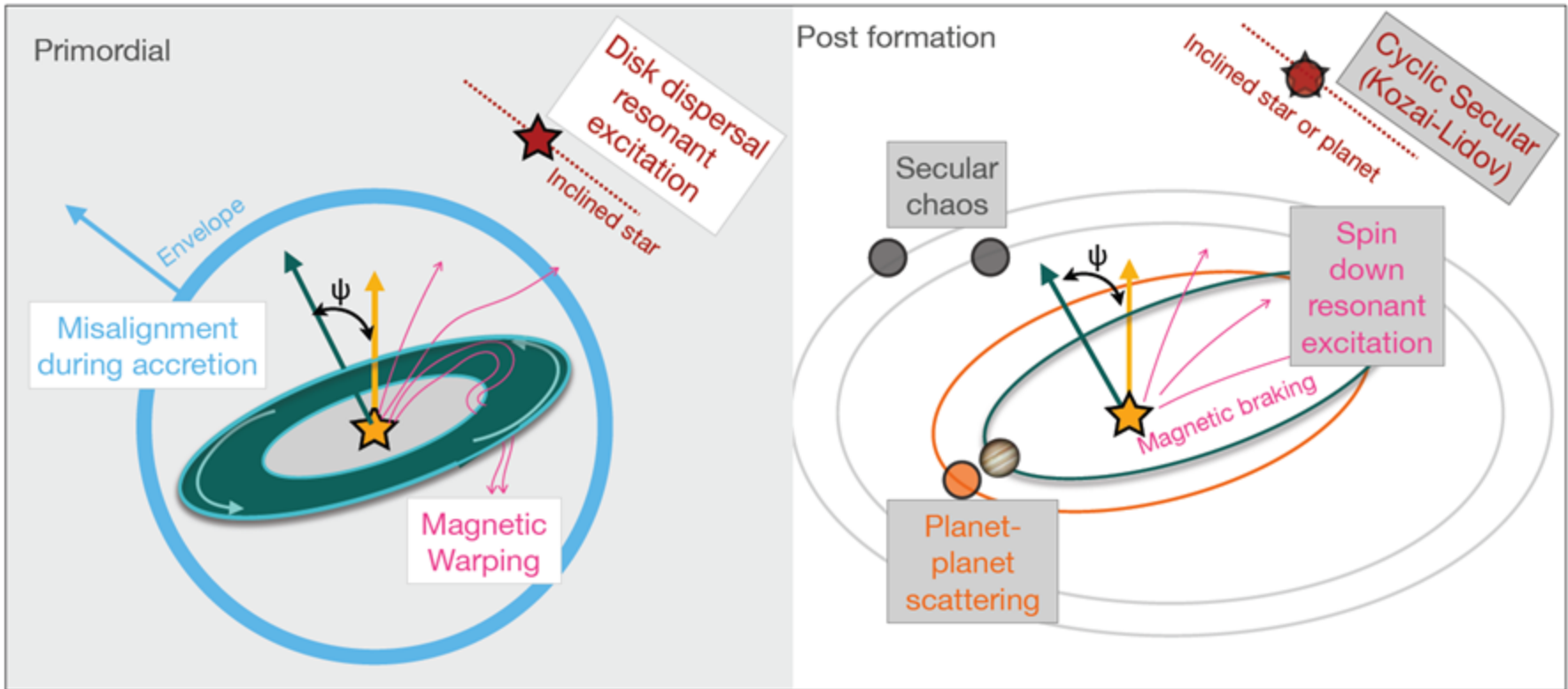


Holt 1893, Schlesinger 1910,
Rossiter 1924, McLaughlin 1924

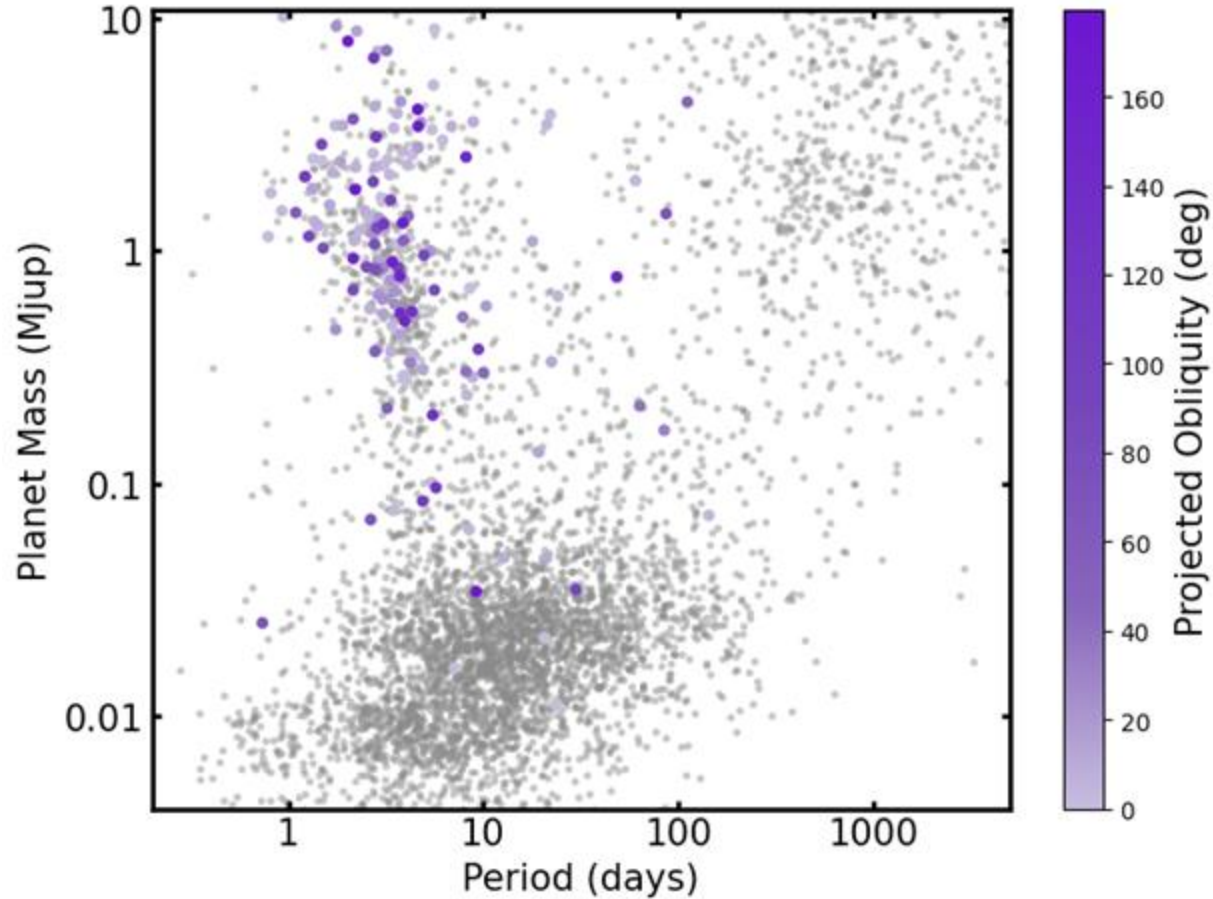
Universal Trait or High-e Signature?

Affect all types of planets

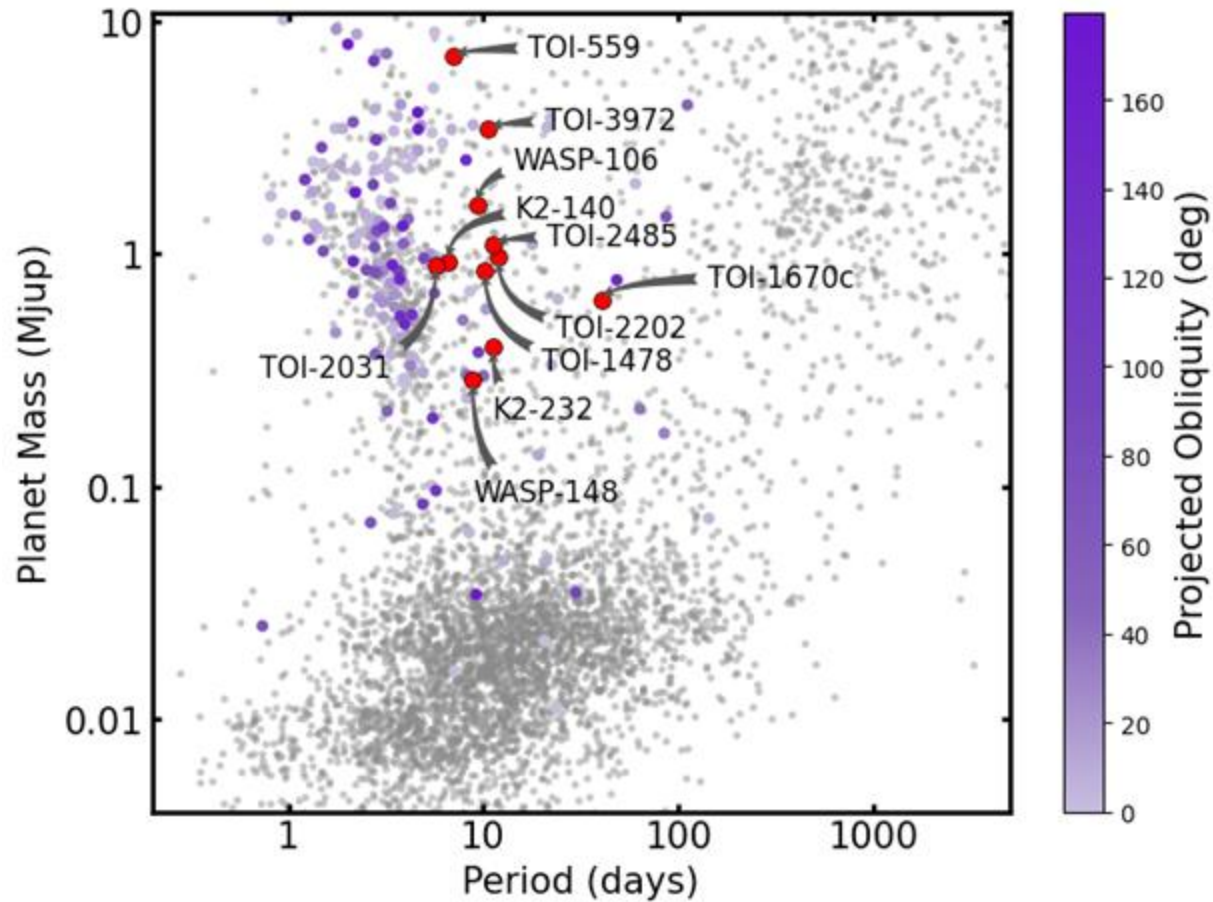
Confine to Hot Jupiters



Most R-M Measurements are for hot Jupiters



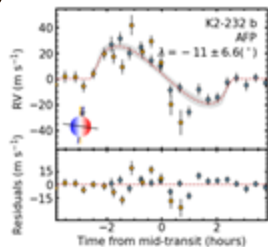
SOLES: Stellar Obliquities in Long-Period Exoplanet Systems



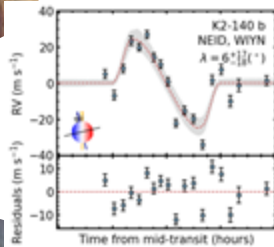
R-M Measurements for 12 Warm Jupiters



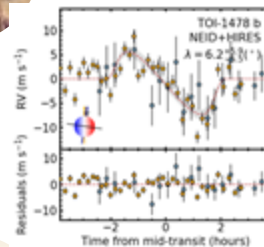
Wang S et al. 2021



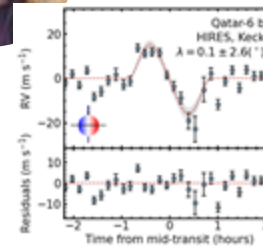
Rice et al. 2021



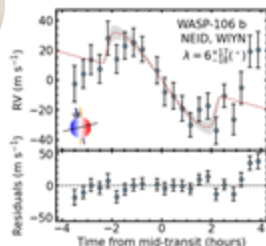
Rice, et al. 2022



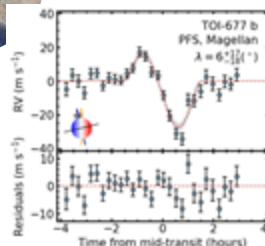
Rice, et al. 2023



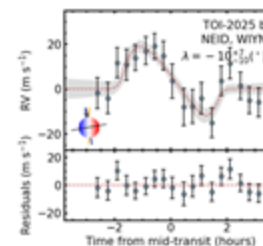
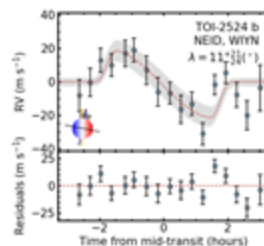
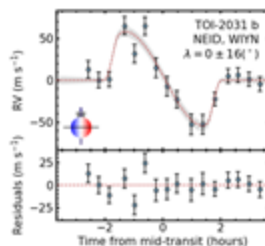
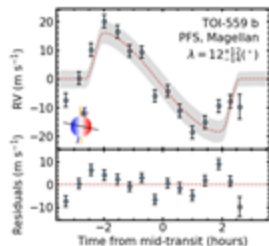
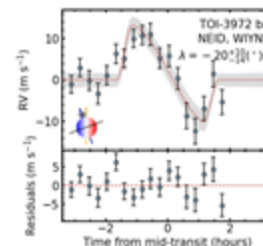
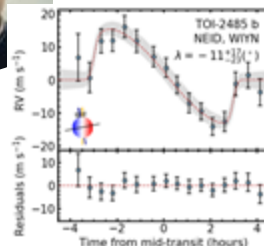
Wright, et al. 2022



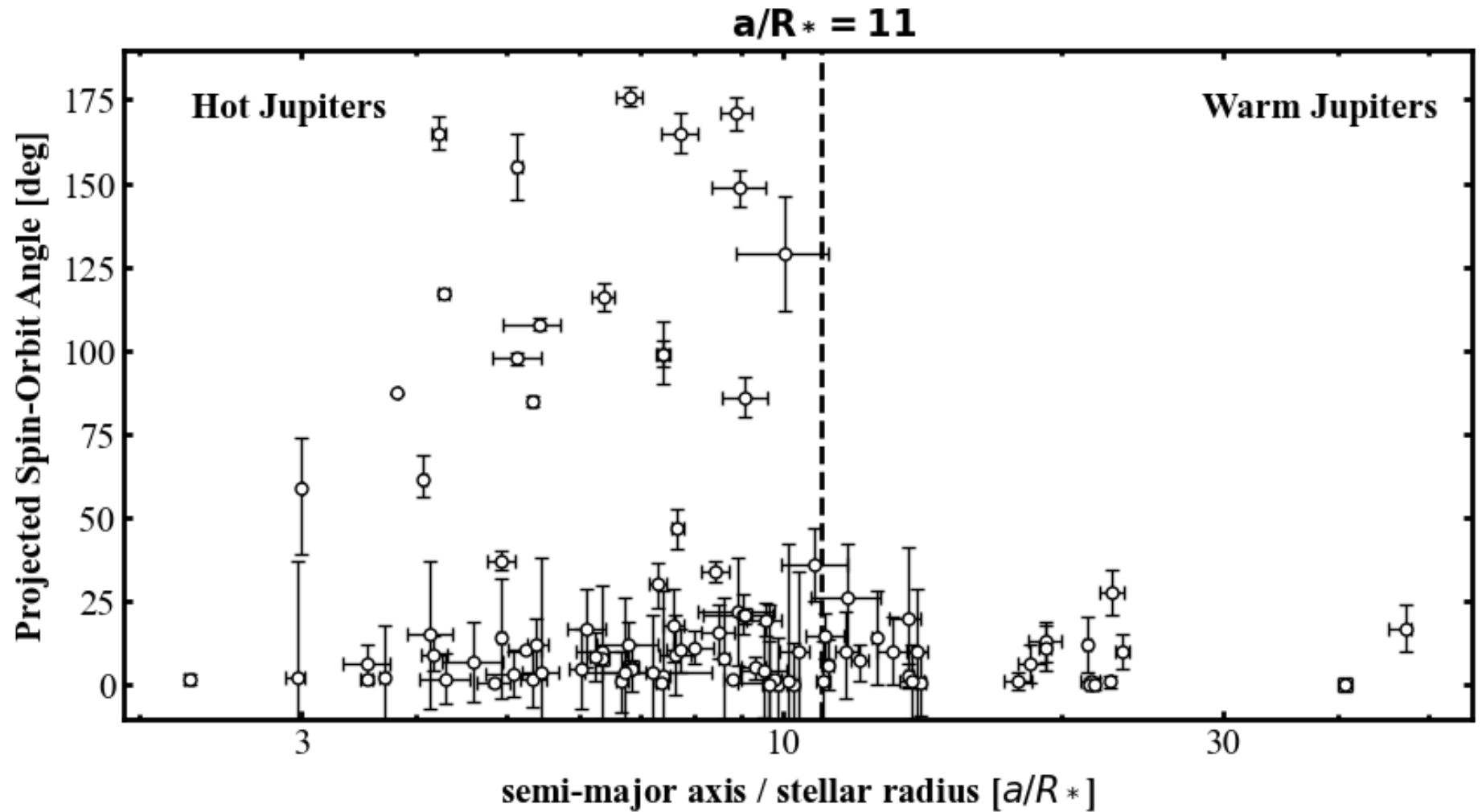
Hu, et al. 2024



Wang X, et al. 2024



Warm Jupiters tend to be Spin-orbit Aligned



Our New Perspective

- Hot Jupiters are sometimes misaligned
- Warm Jupiters tend to be aligned

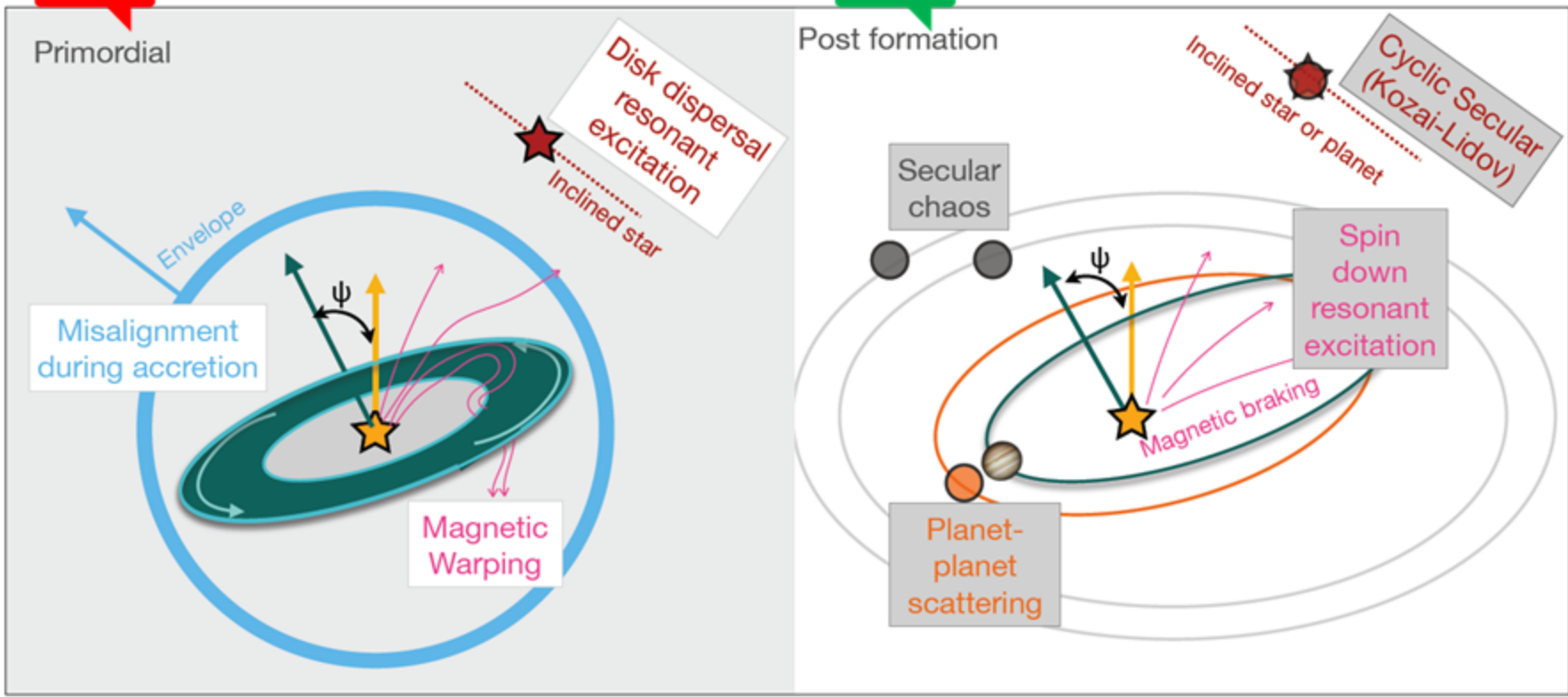
Primordial Alignment and Post formation Misalignment

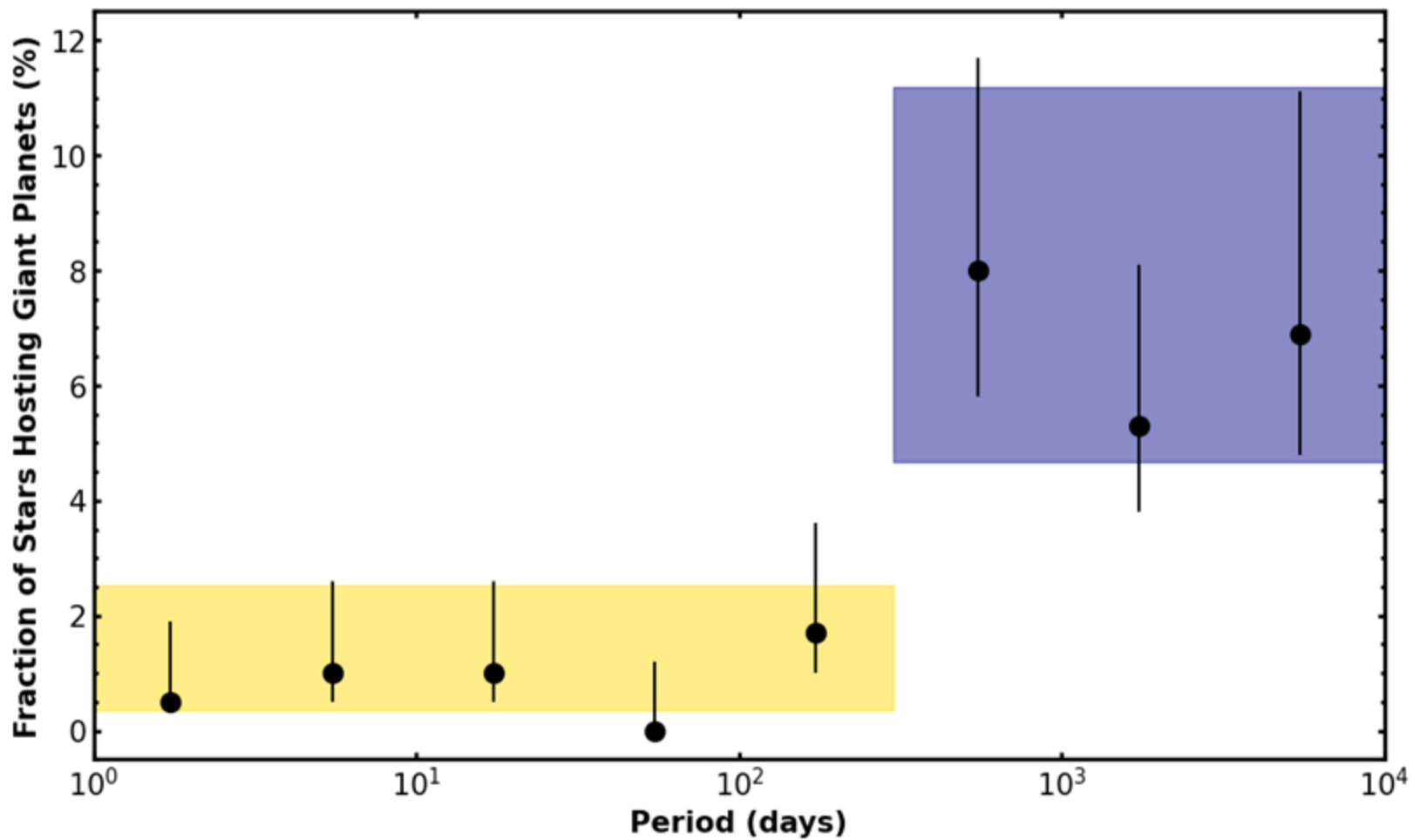


Affect all types of planets

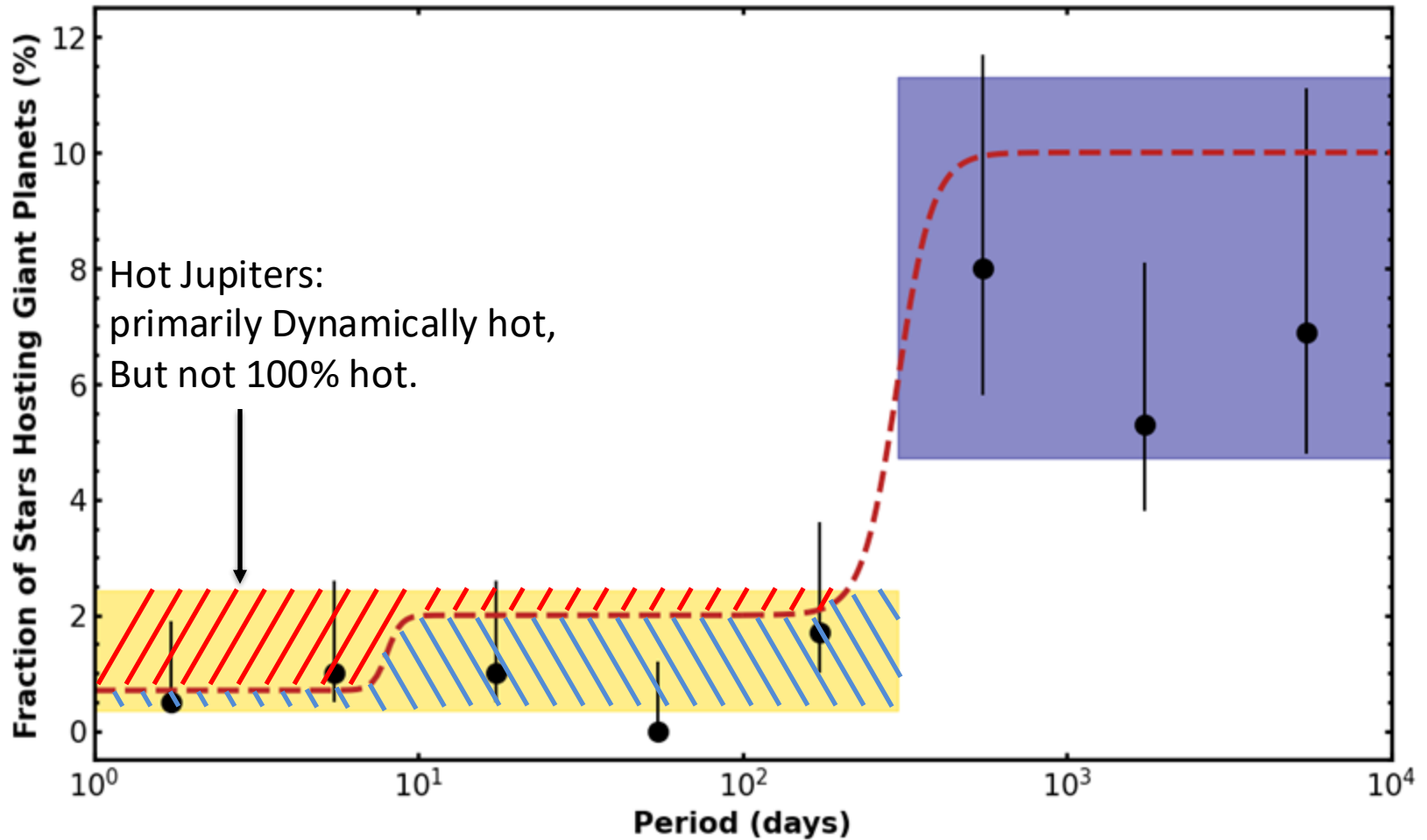


Confine to Hot Jupiters

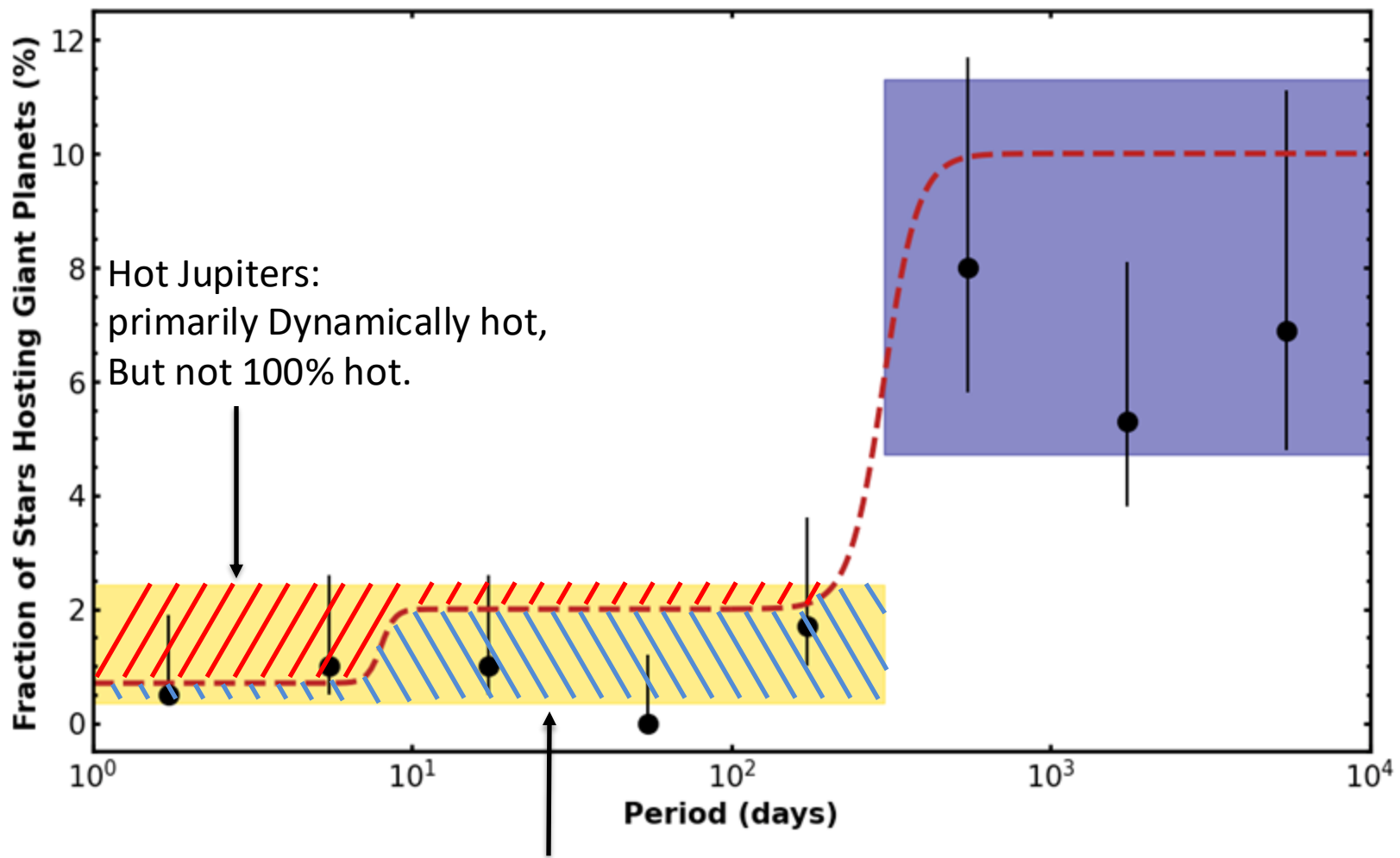




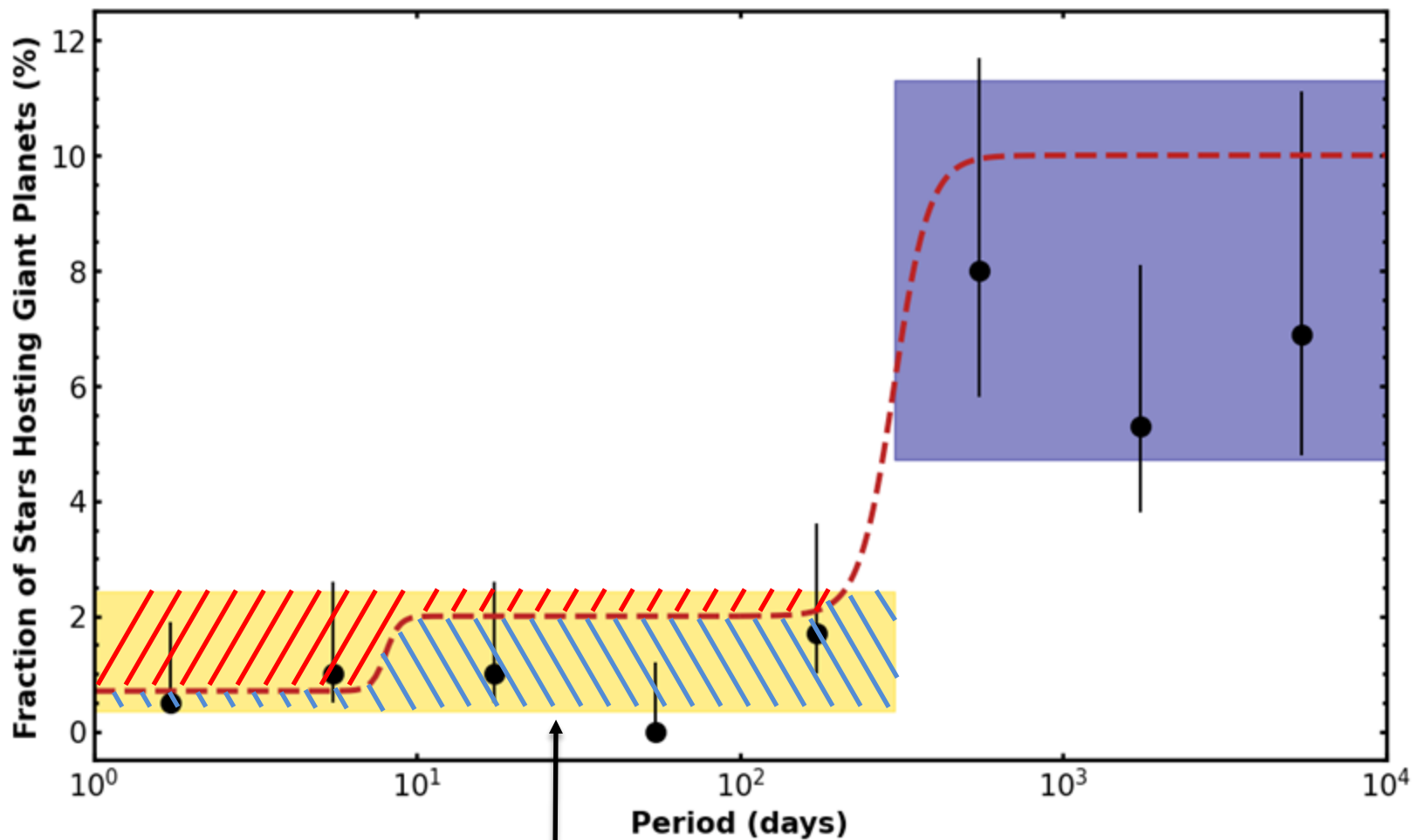
Hot Jupiters are mostly dynamically hot, but not 100%



Warm Jupiters are mostly dynamically cool, but not 100%

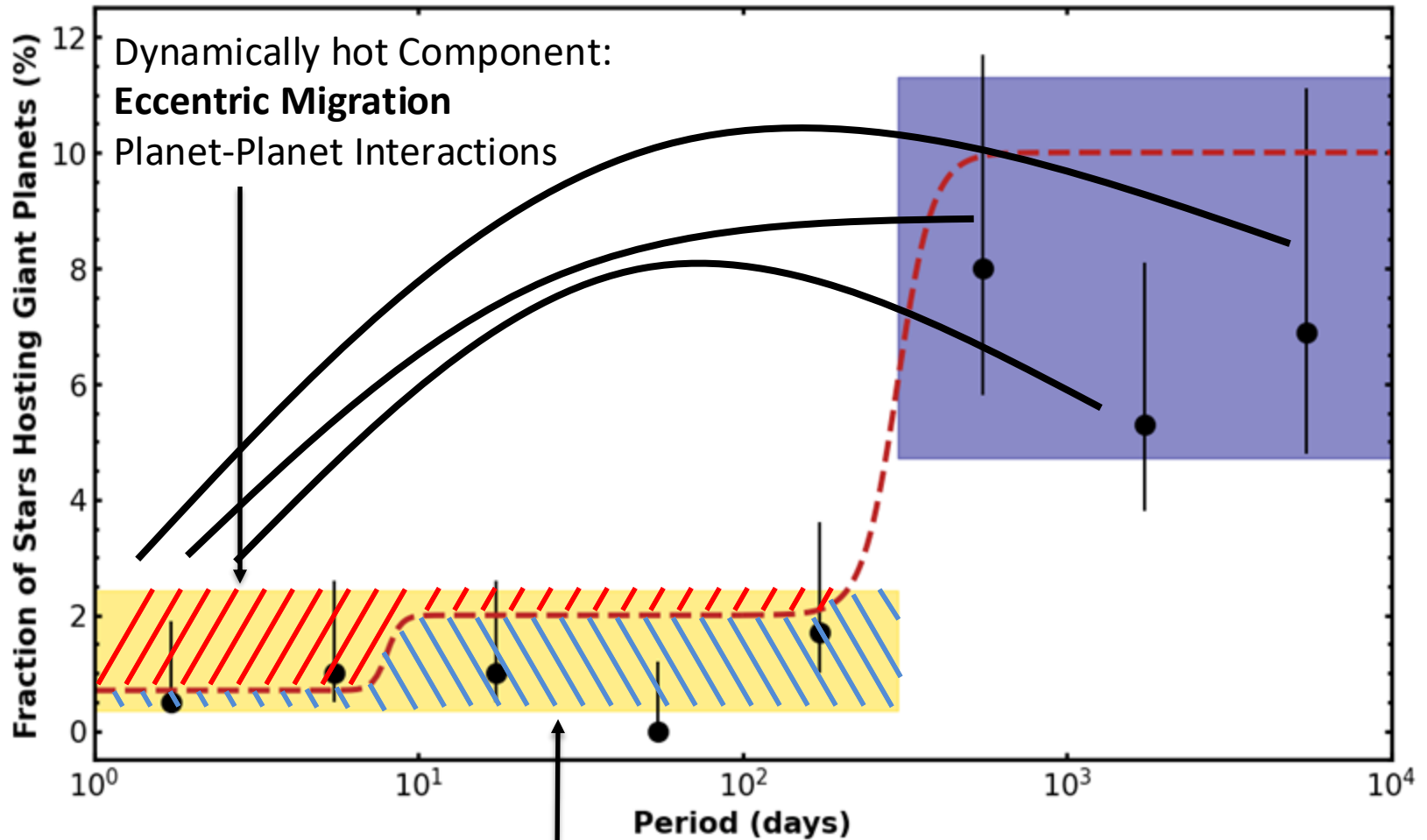


Warm Jupiters: *in situ* or disk migration



Dynamically Cool Component:
Either **In Situ** or **Disk Migration**

Hot Jupiters: Eccentricity Migration

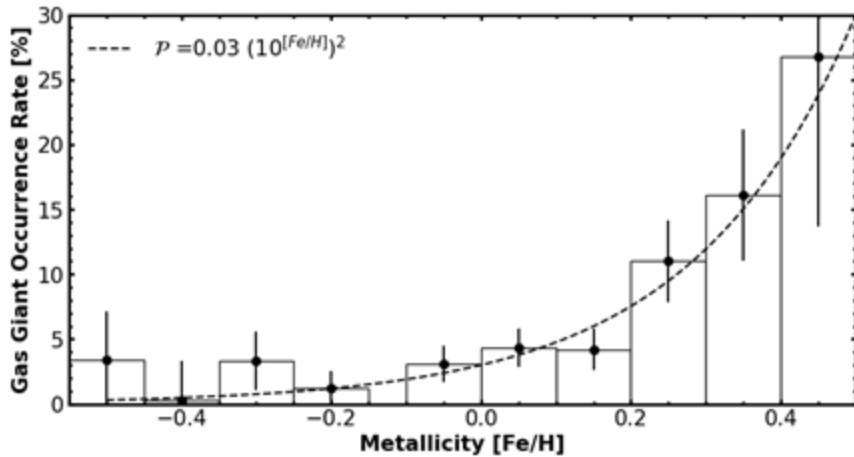


Dynamically hot Component:
Eccentric Migration
Planet-Planet Interactions

Dynamically Cool Component:
Either **In Situ** or **Disk Migration**

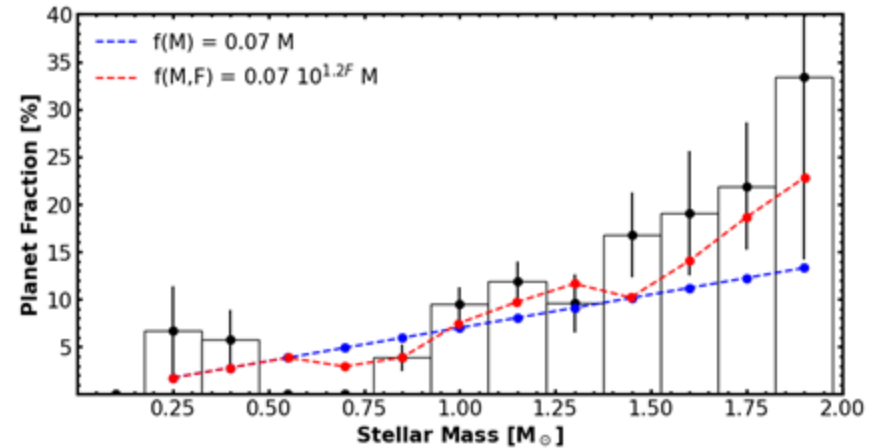
Dynamically Hot Systems: Massive or Metal-rich?

The Jupiter-Fe/H Correlation



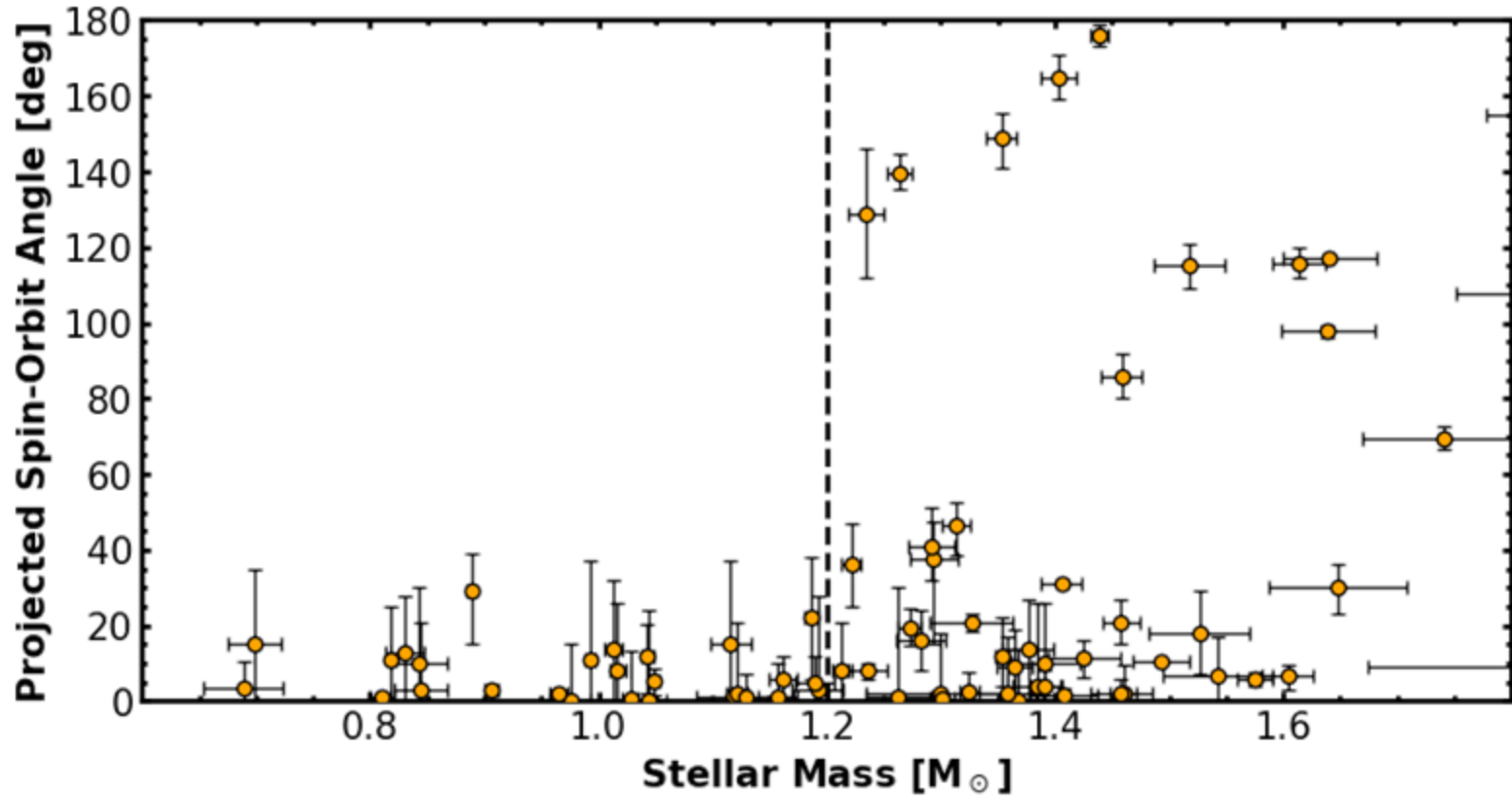
Modified from Fischer & Valenti 2005

The Jupiter-M* Correlation

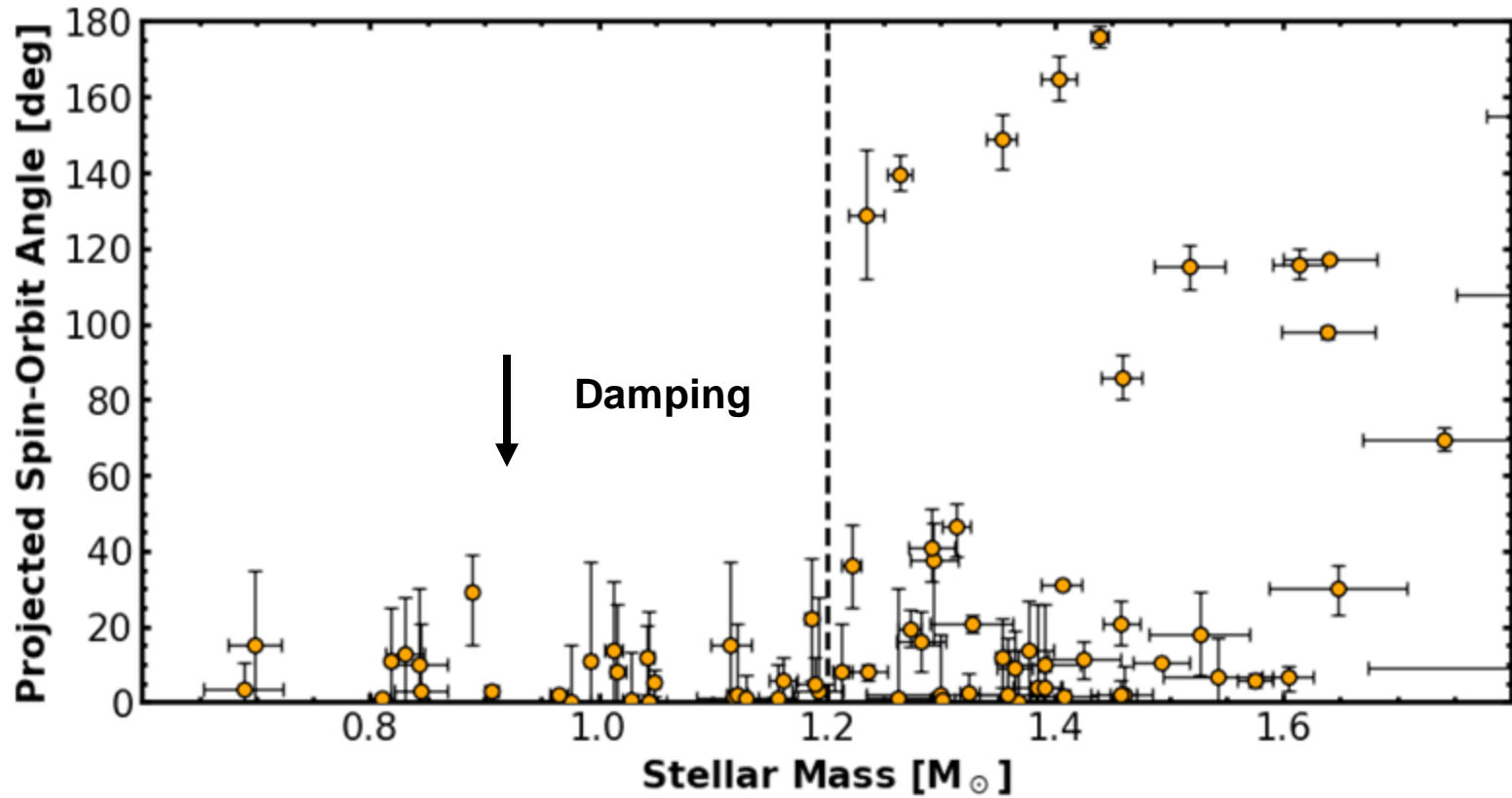


Modified from Johnson et al. 2010

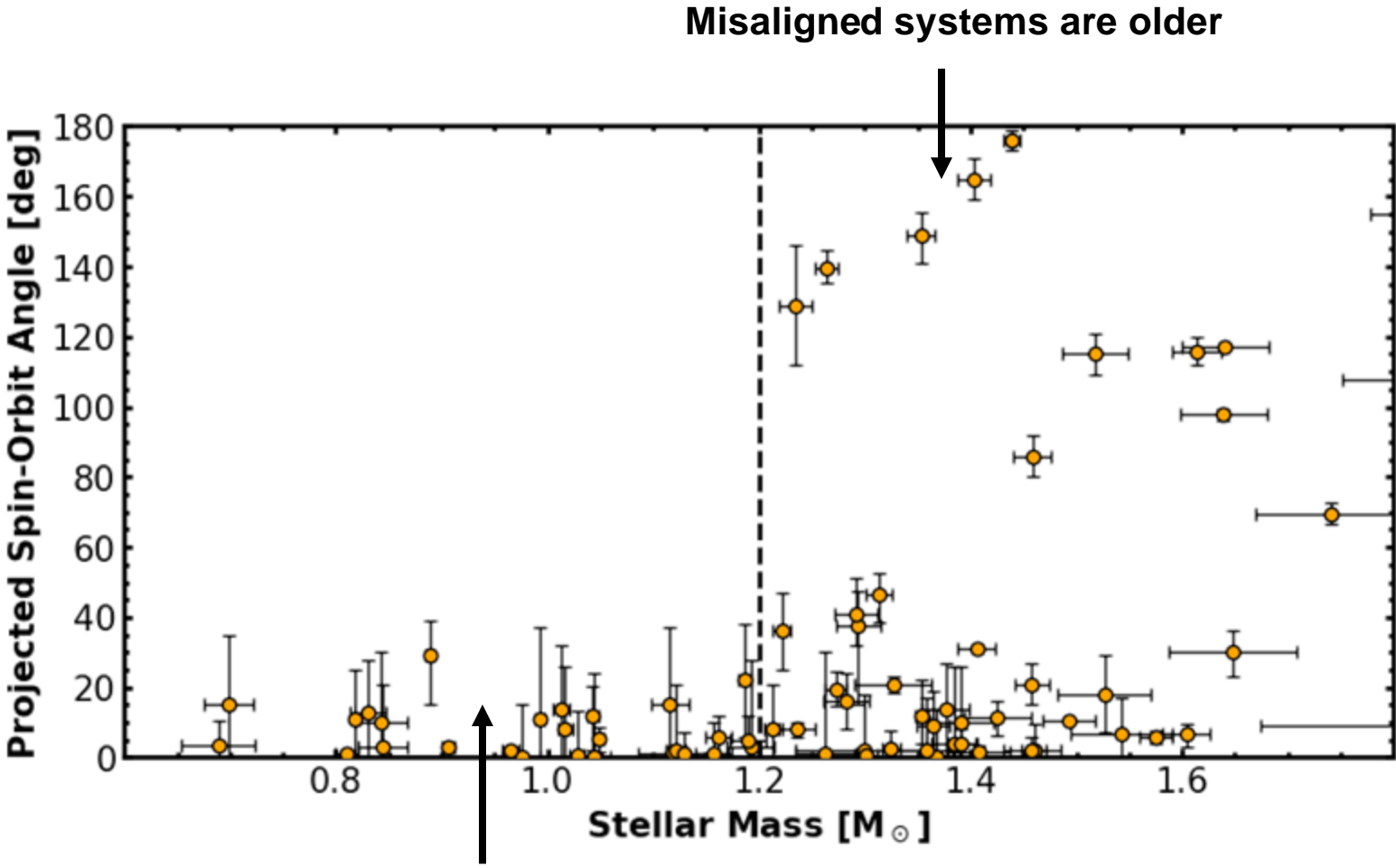
HJs around Massive Stars tend to be Misaligned



Tidal Damping?



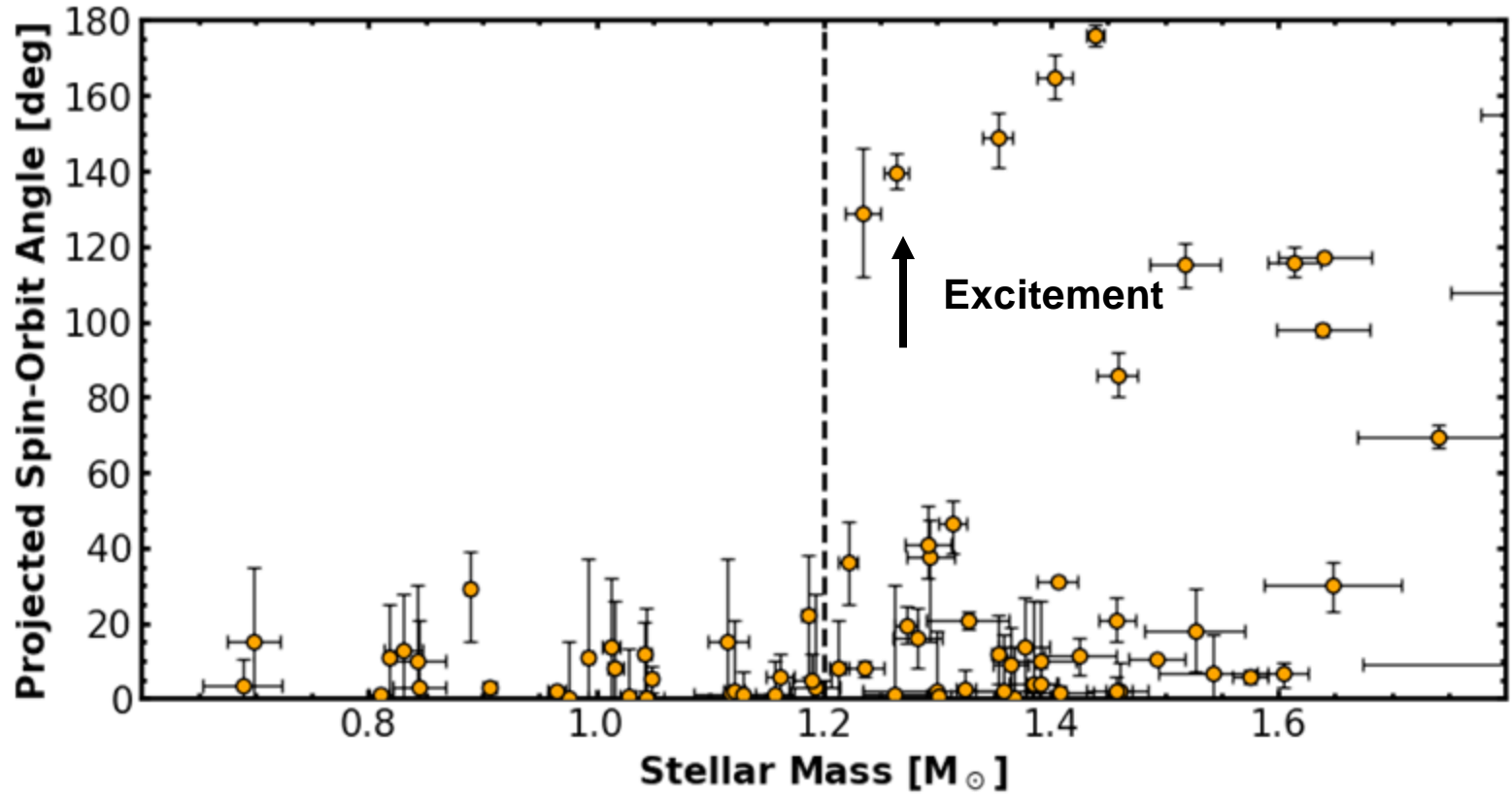
Aligned Systems are younger than misaligned ones



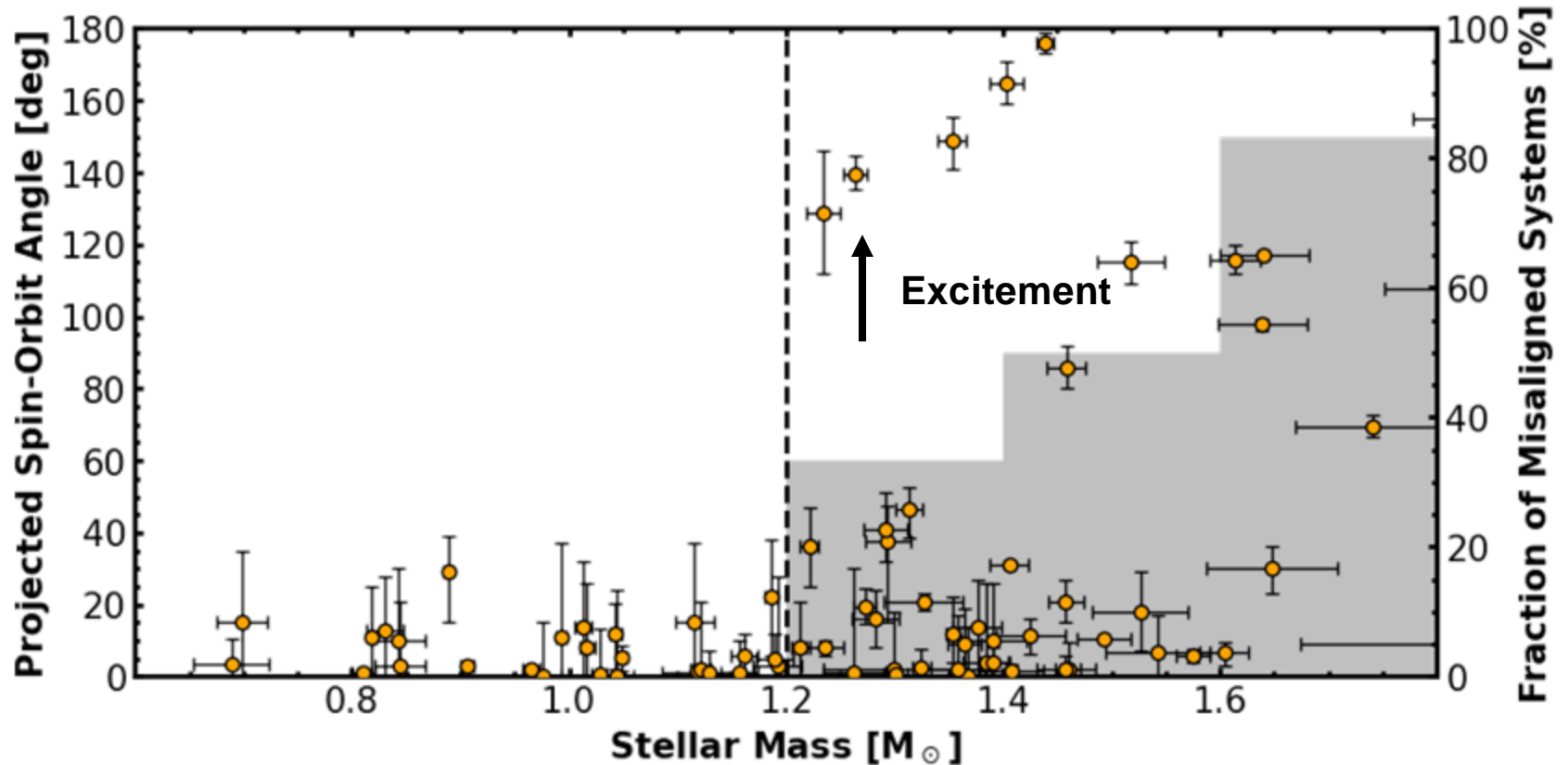
Aligned systems are younger

Hamer & Schlaufman 2022

Dynamical Excitement



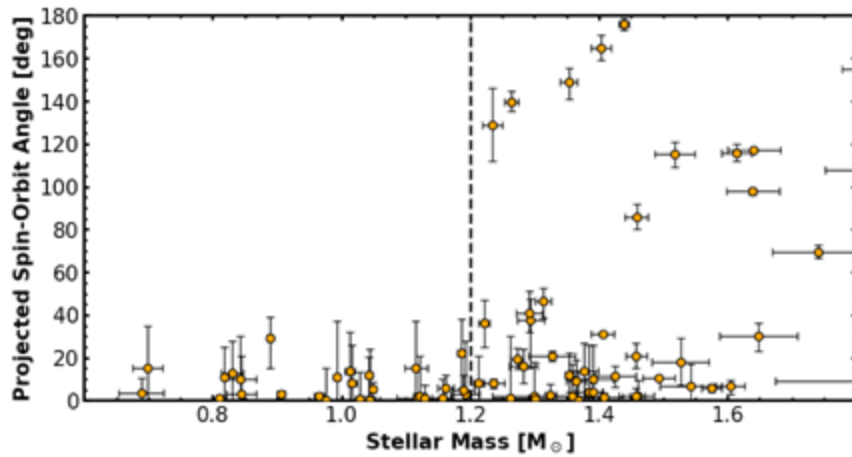
Higher T_{eff}/M_* , More Likely to be Misaligned



See also Albrecht et al. 2022

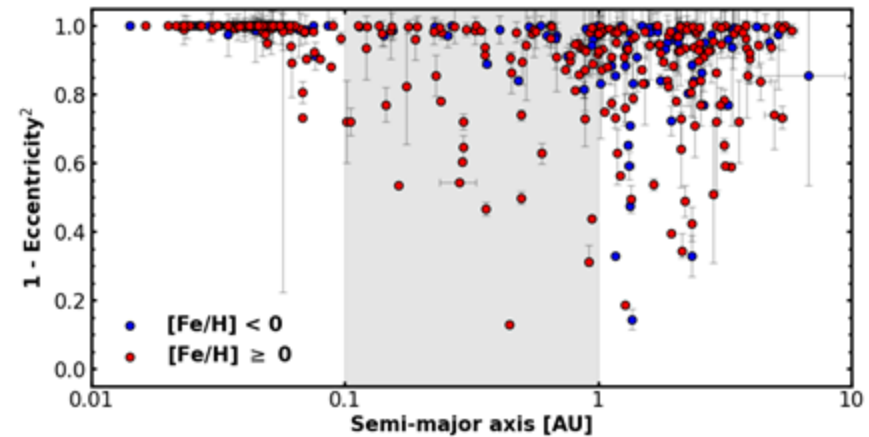
Puzzling Discrepancy: $T_{\text{eff}}/M_* - \lambda$ vs. $\text{Fe}/\text{H} - e$

The $T_{\text{eff}}/M_* - \lambda$ Correlation



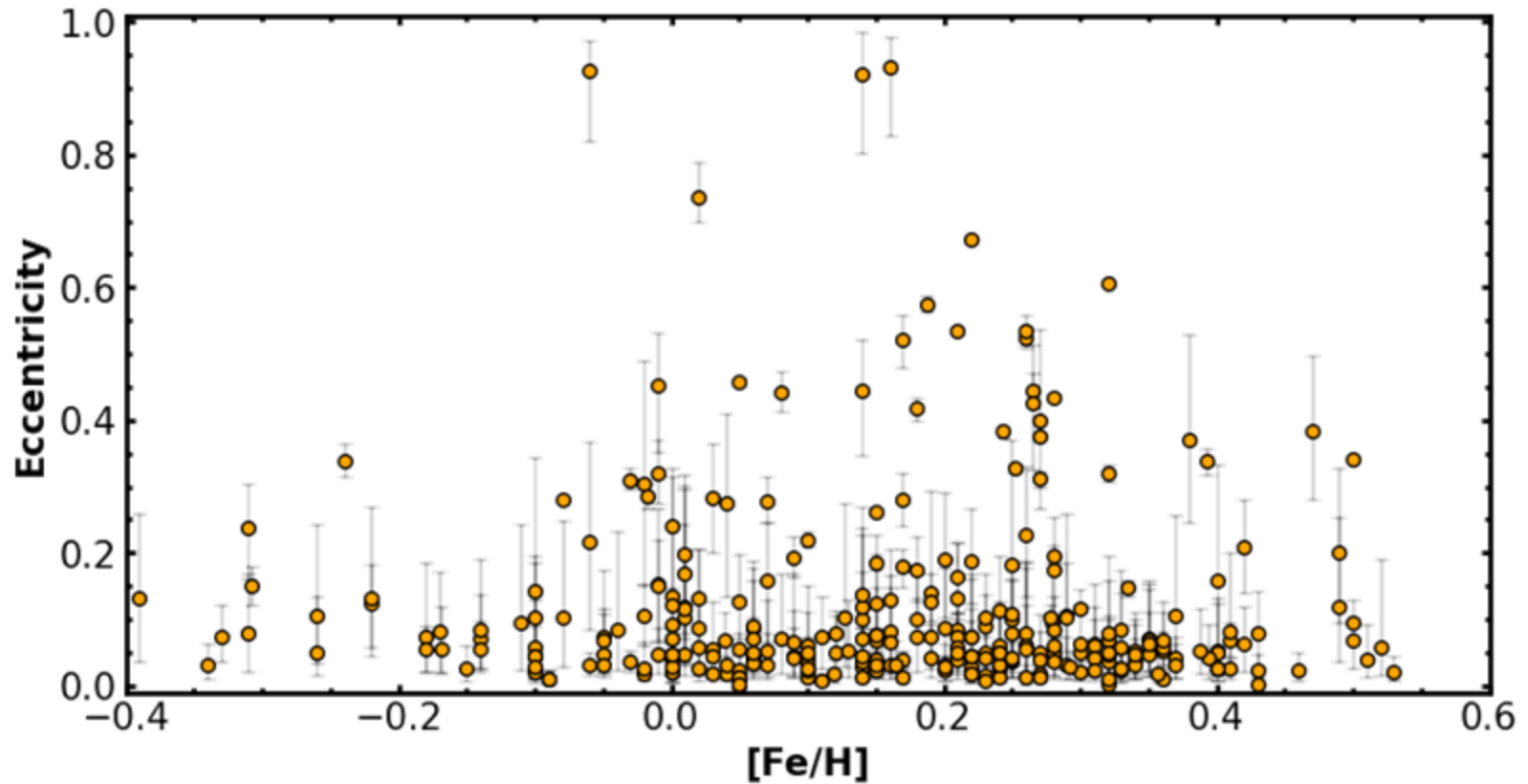
See Schlaufman 2010
Winn et al. 2010
Albrecht et al. 2022

The $\text{Fe}/\text{H} - e$ Correlation

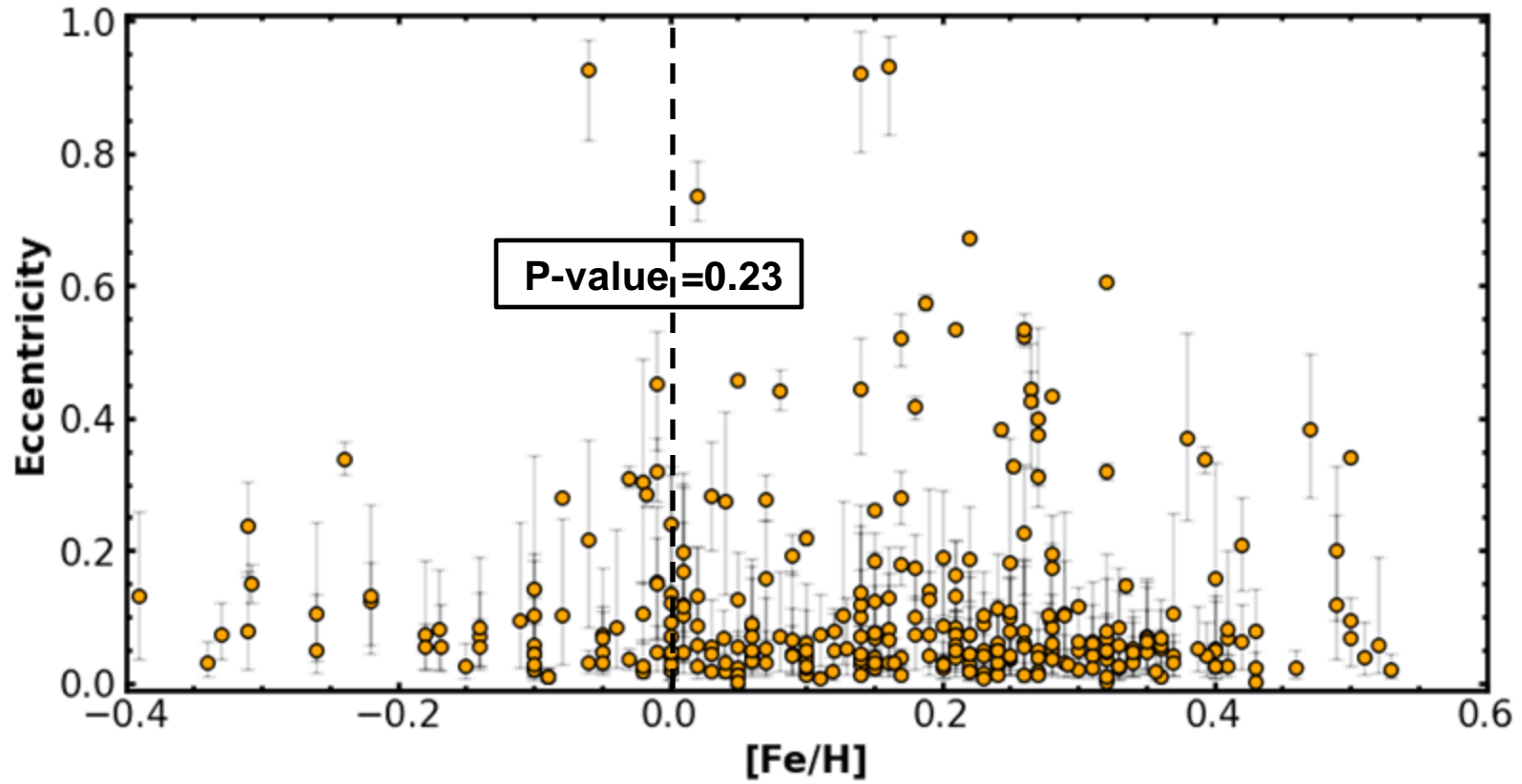


Modified from Dawson & Murray-Clay 2013

Checking the Fe/H-e Correlation

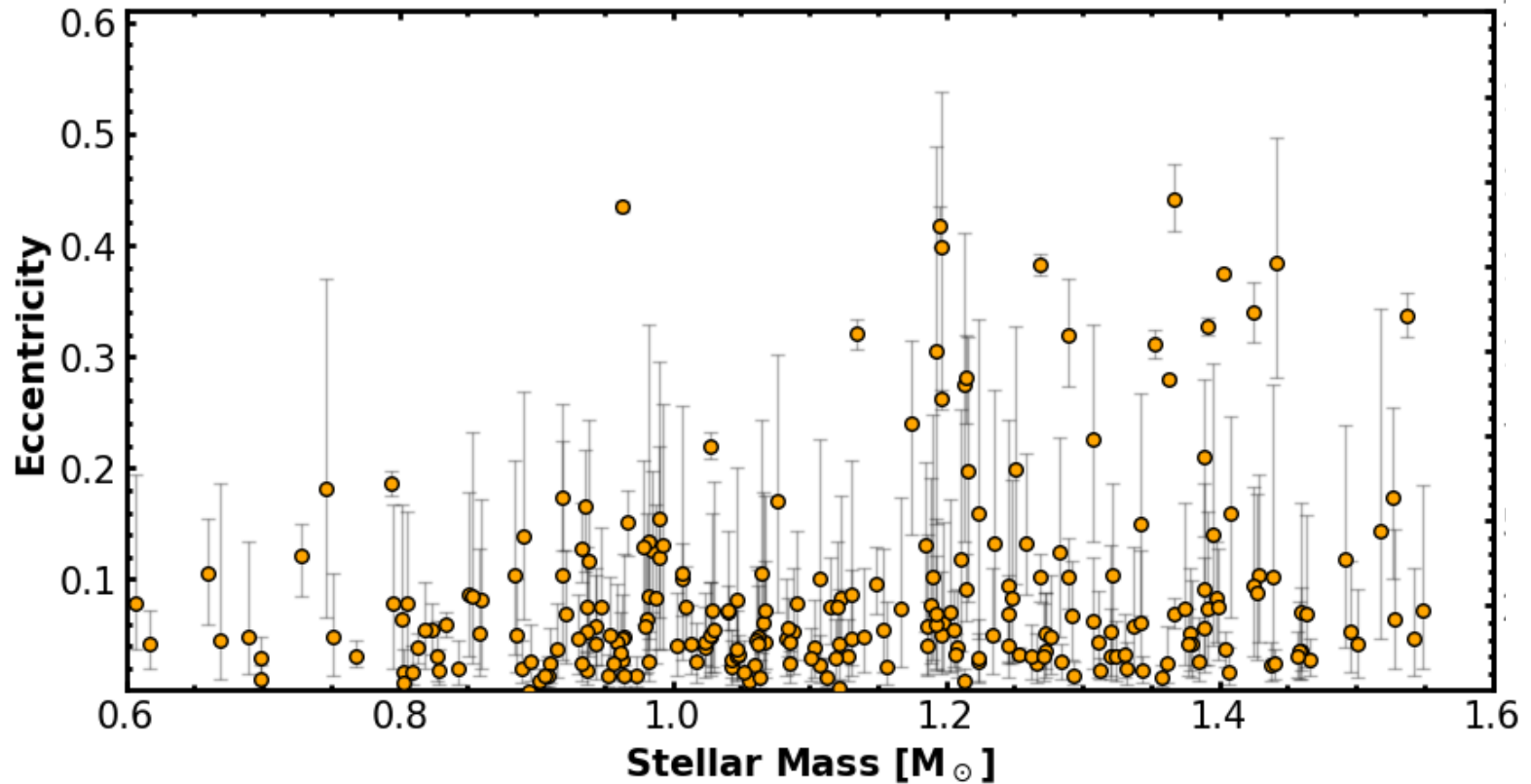


Checking the Fe/H-e Correlation: Insignificant

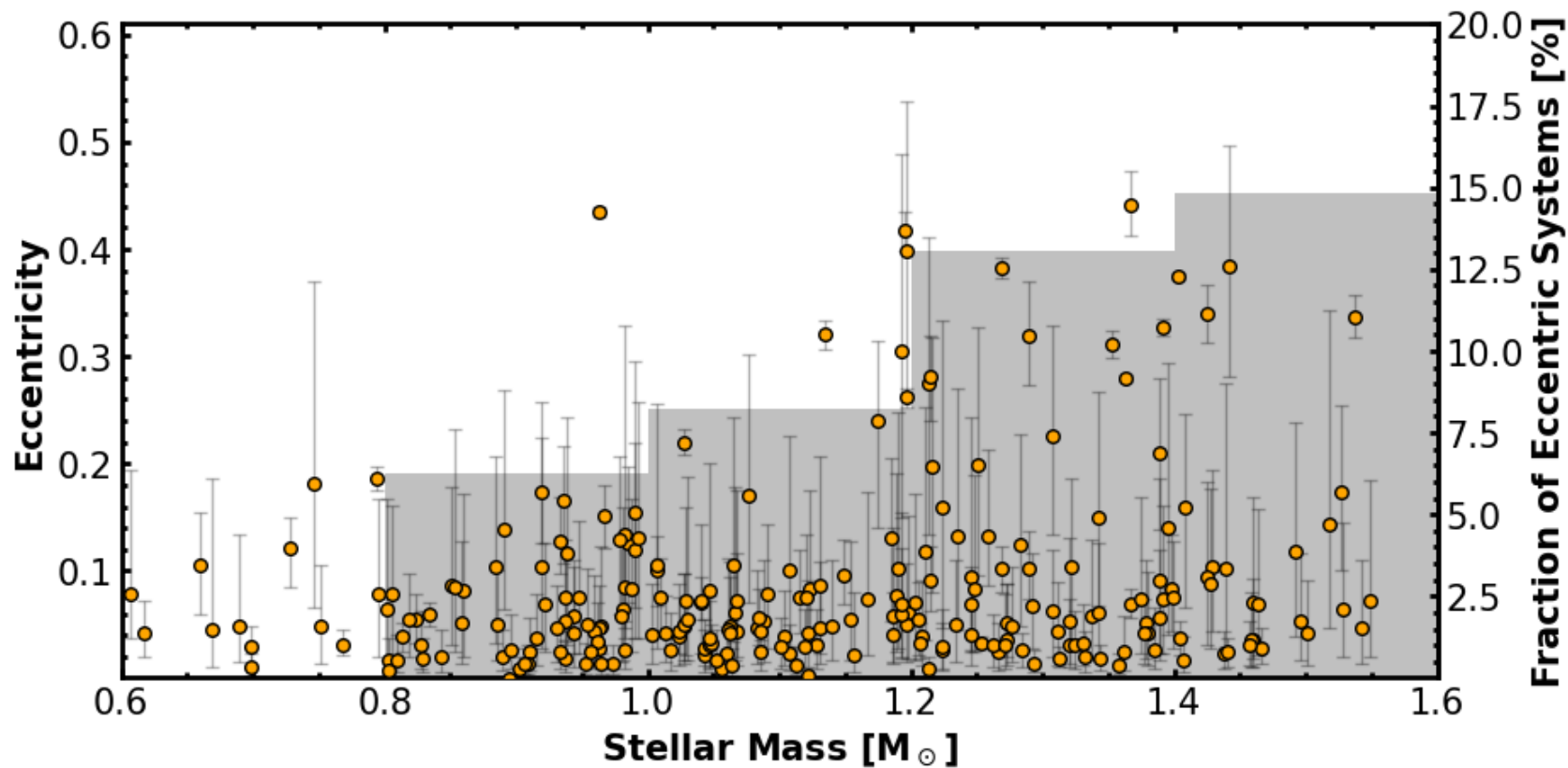


See also Yee & Winn 2023

Examining the T_{eff}/M_* -e Correlation

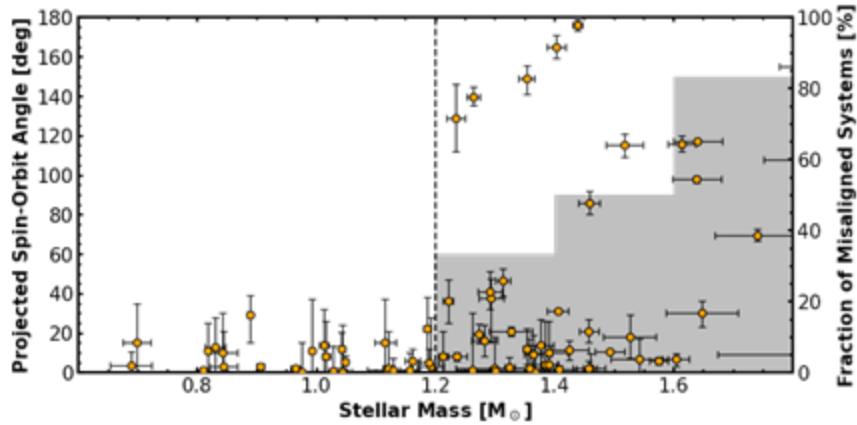


Higher T_{eff}/M_* , More Likely to be Eccentric

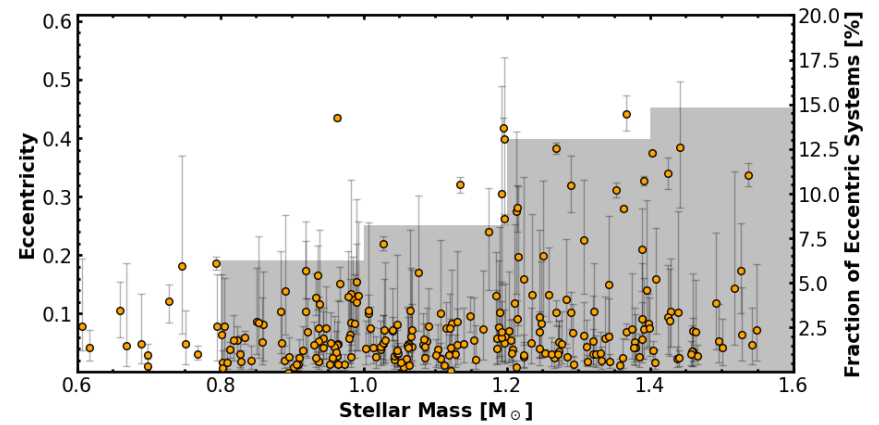


Higher T_{eff}/M_* , More Likely to be Misaligned and Eccentric

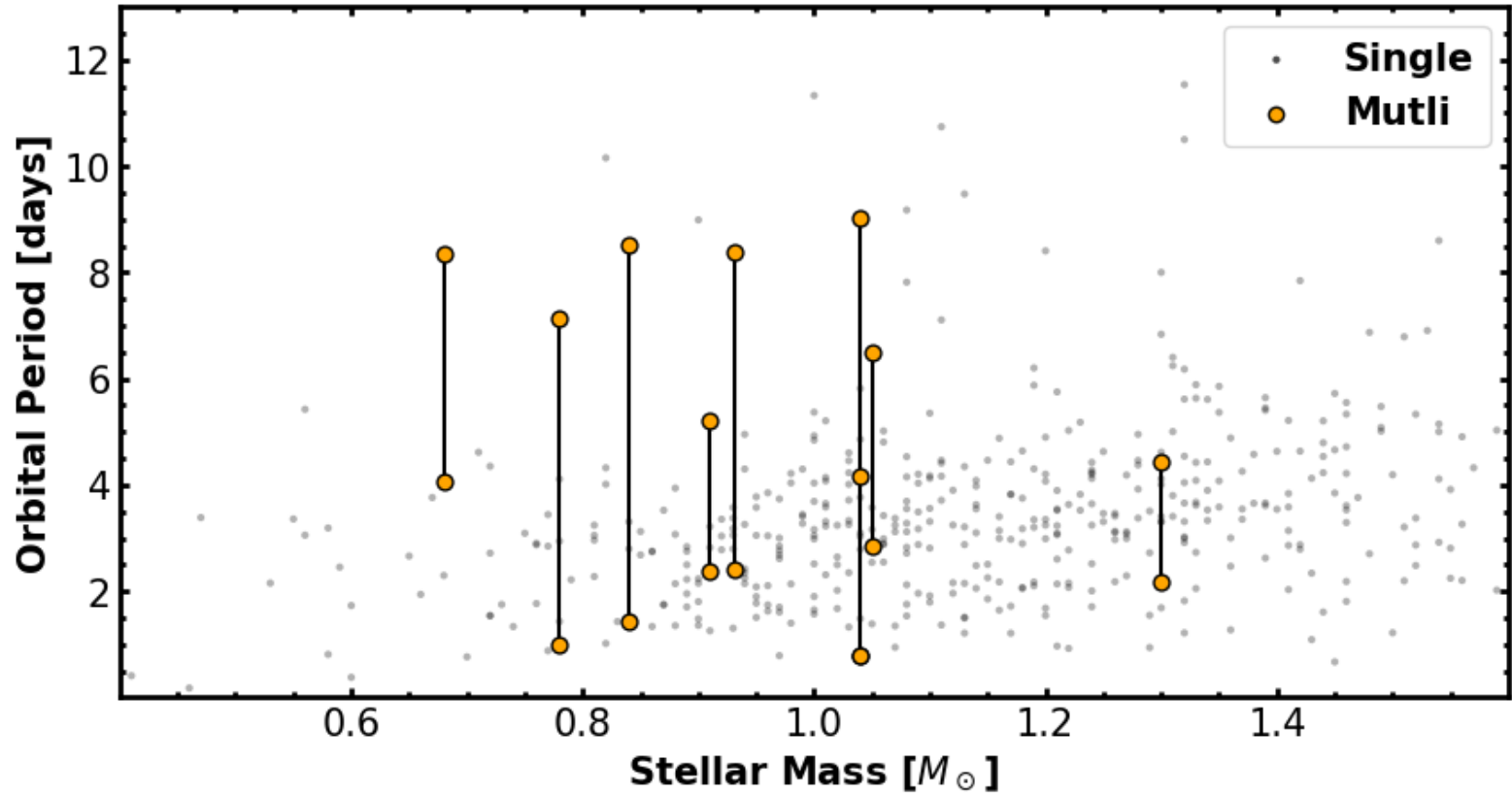
The T_{eff}/M_* - λ Correlation



The T_{eff}/M_* - e Correlation



Higher T_{eff}/M_* , More Likely to be Isolated



Hot Jupiters are Dynamically Hot

Hot Jupiters around Hot Stars are Dynamically Hotter