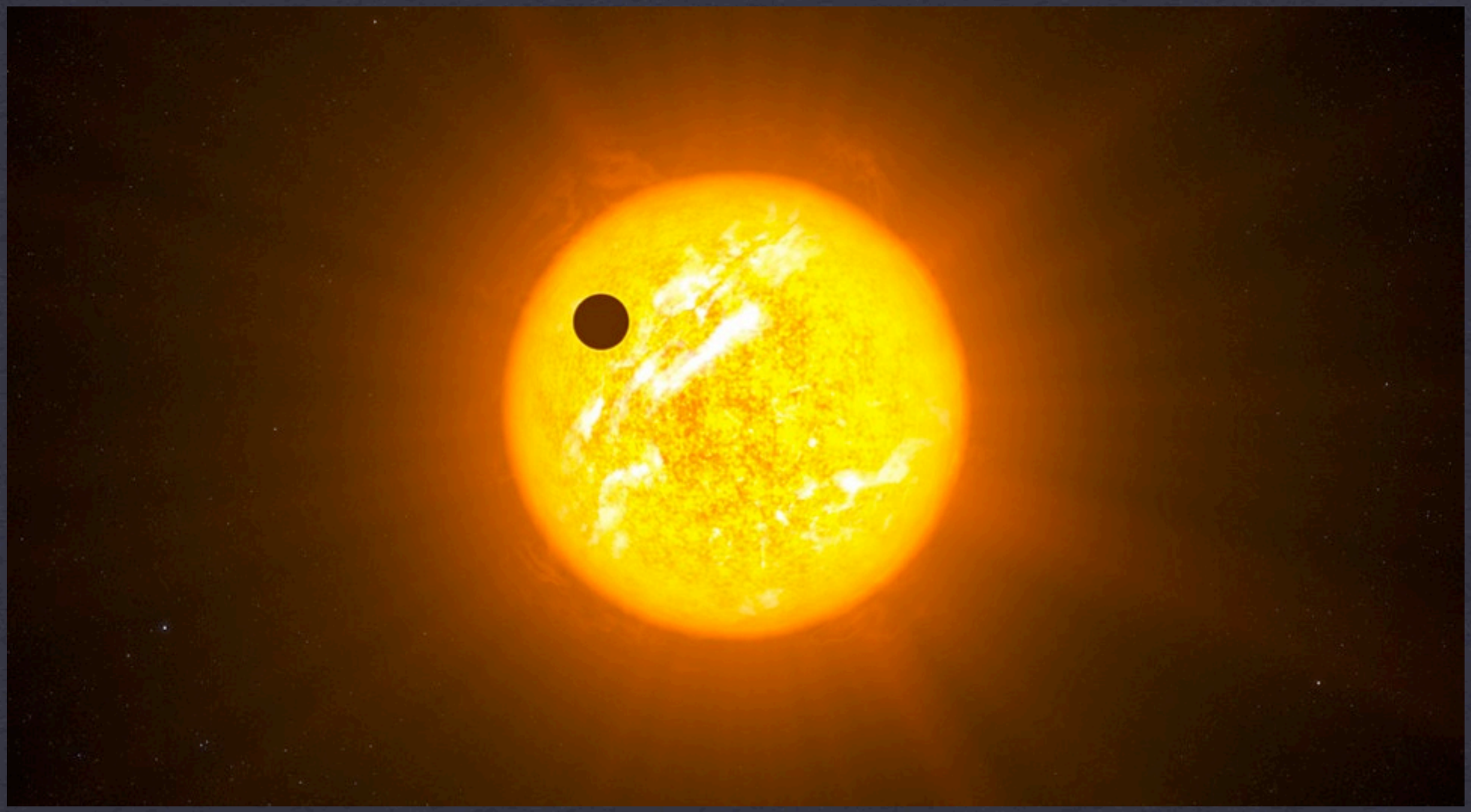

Spin/Orbit measurements & Implications

FLAGSTAFF - 04/05/11

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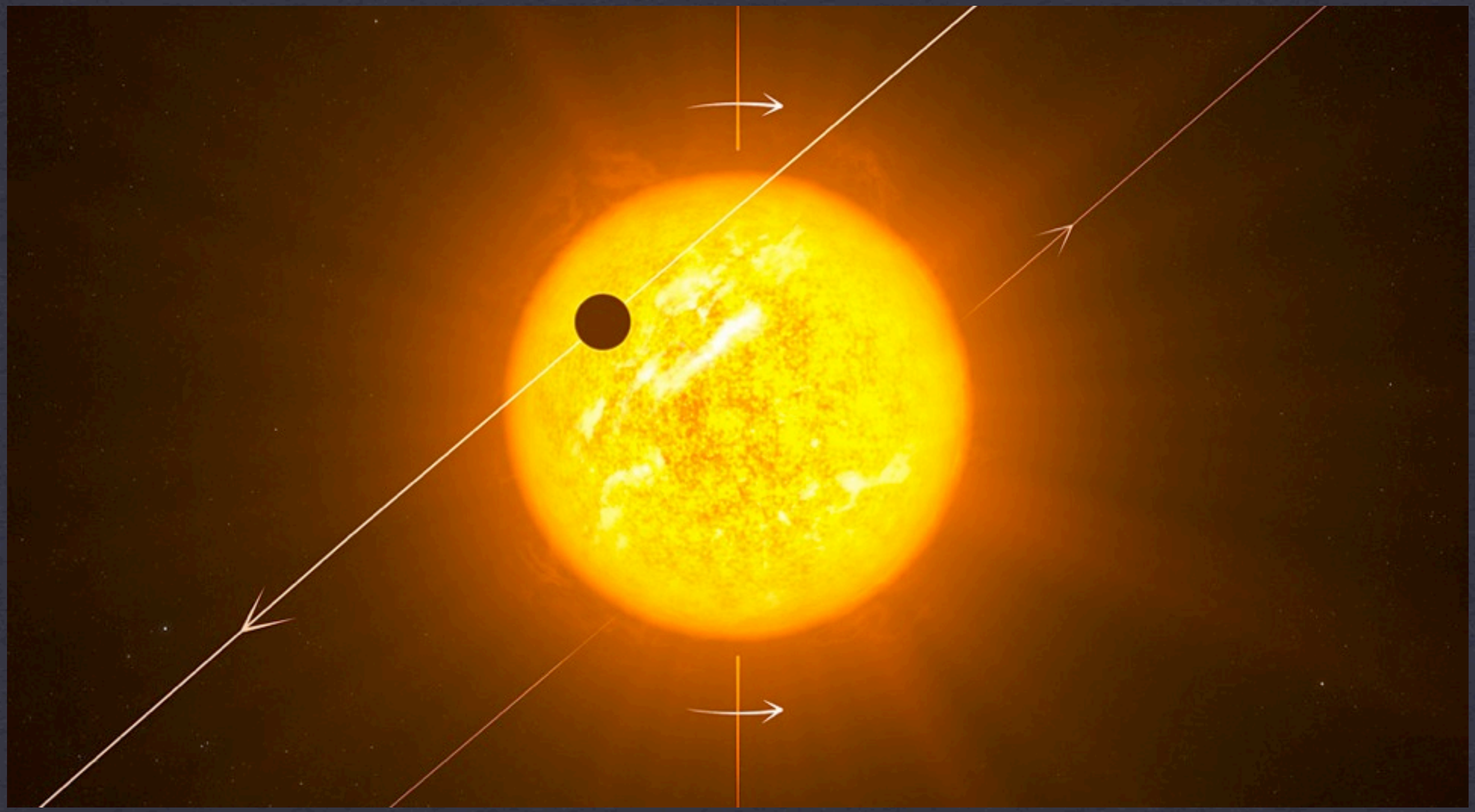

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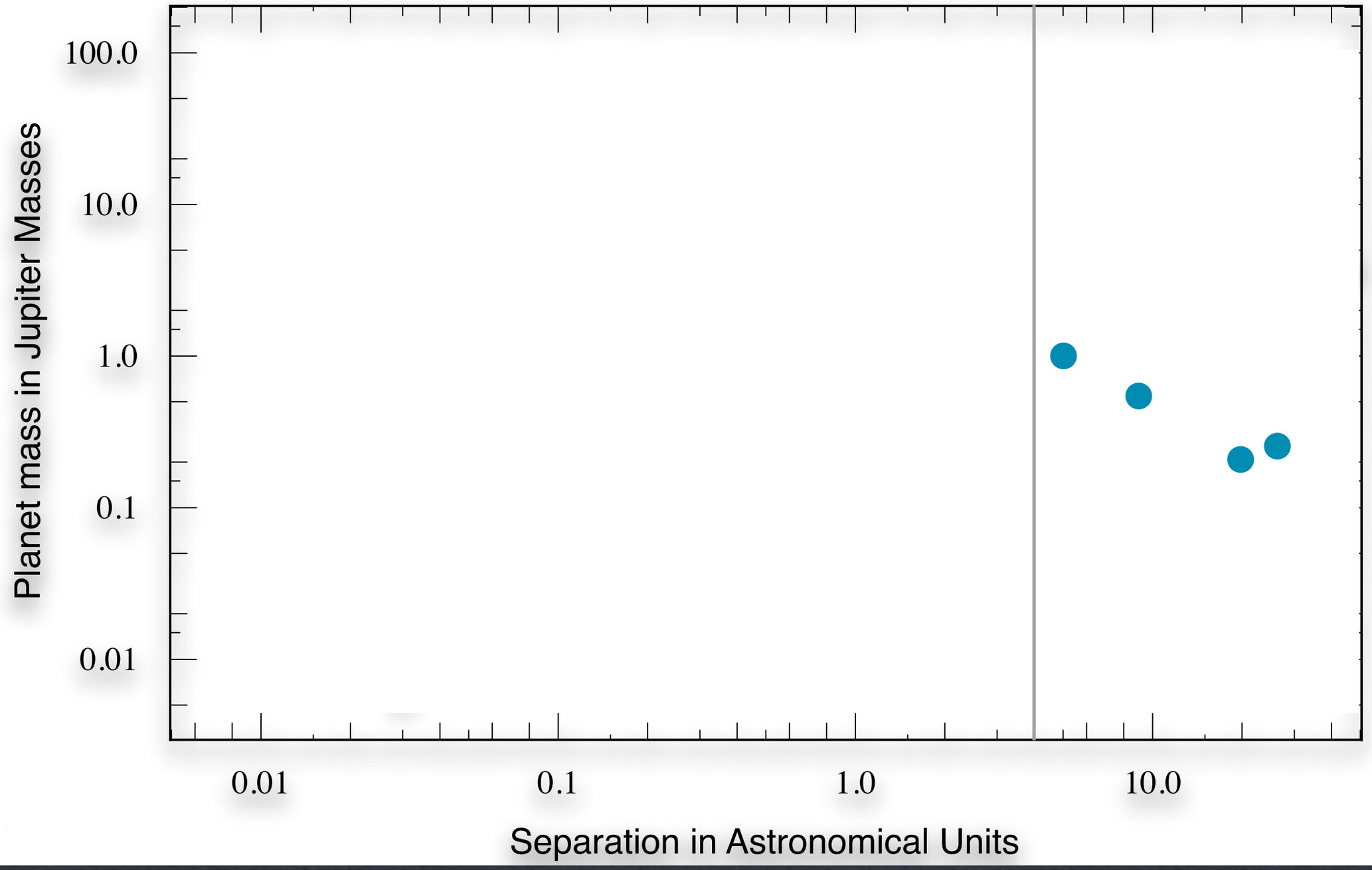
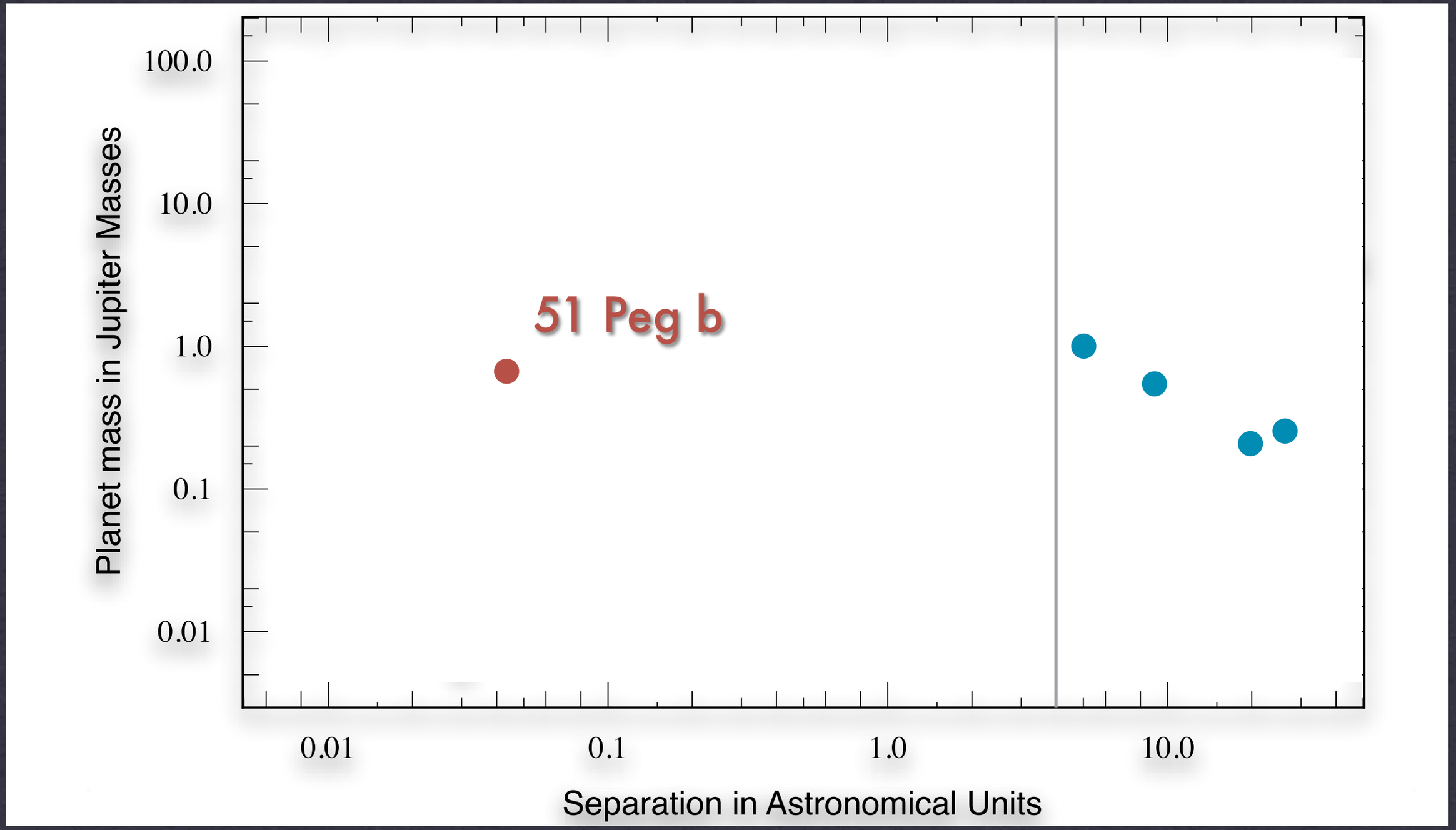


Theory of planetary systems
Planets migrate, but how?

MAYOR & QUELOZ 1995 + EXOPLANET.EU



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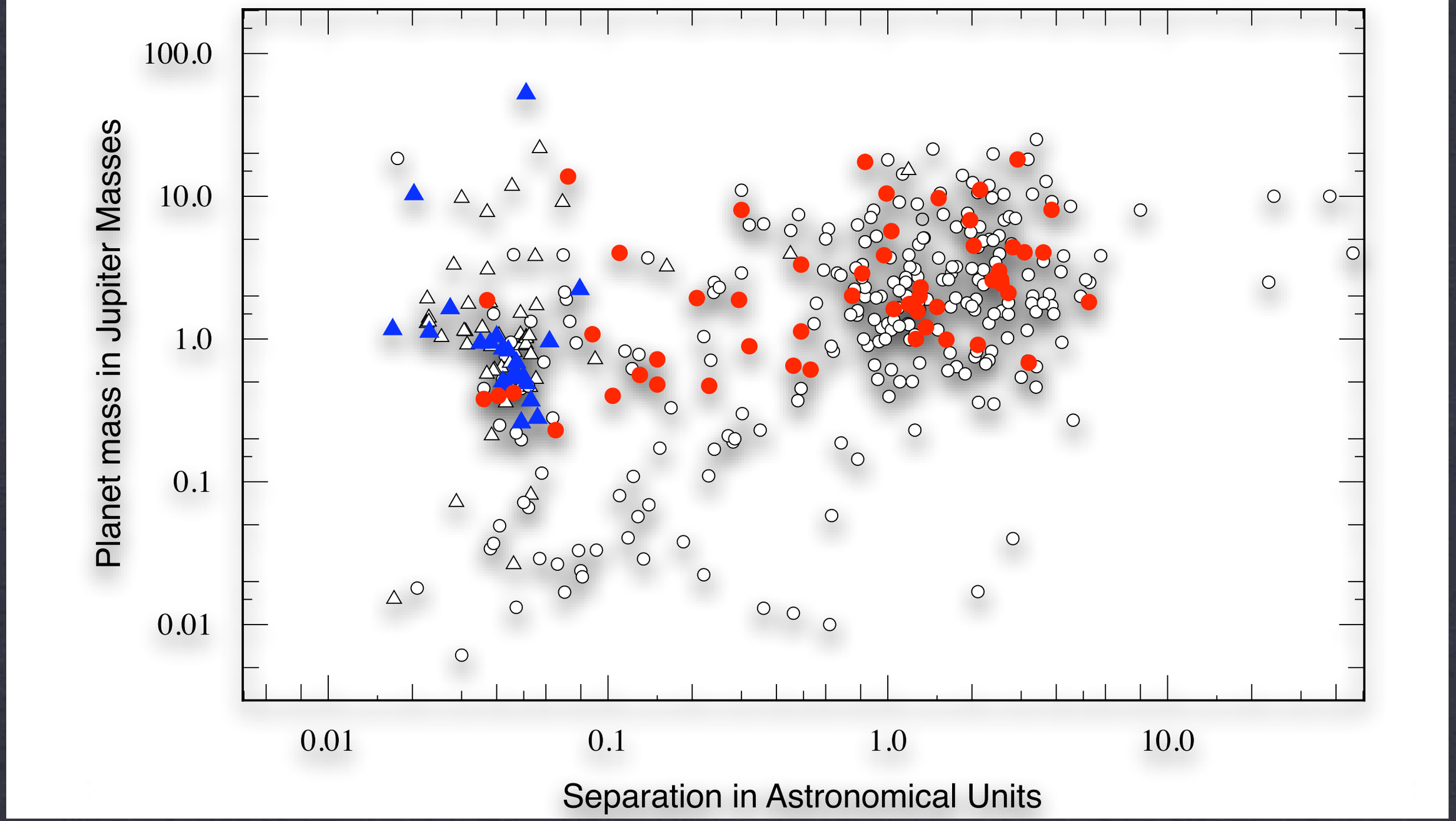

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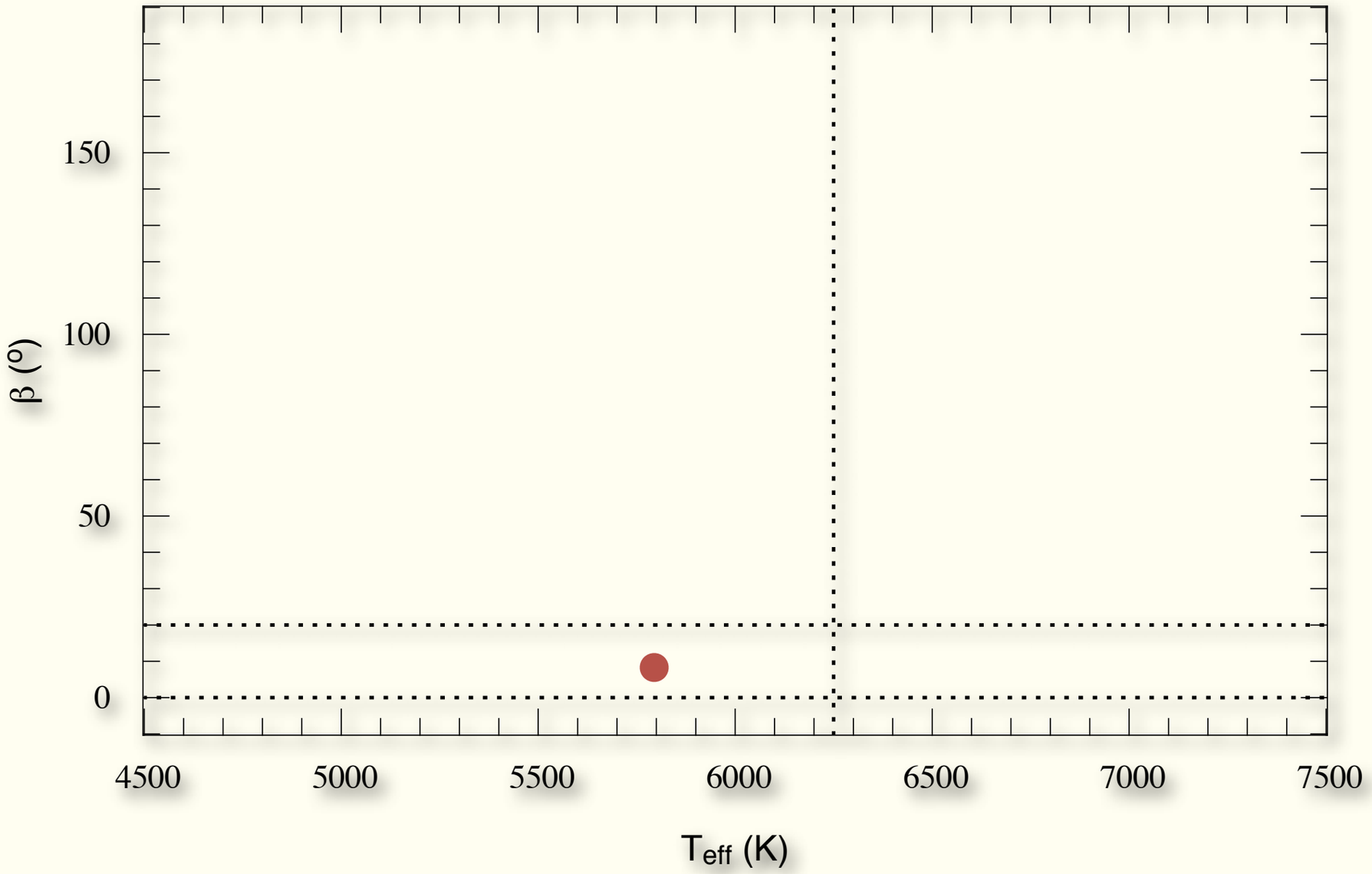

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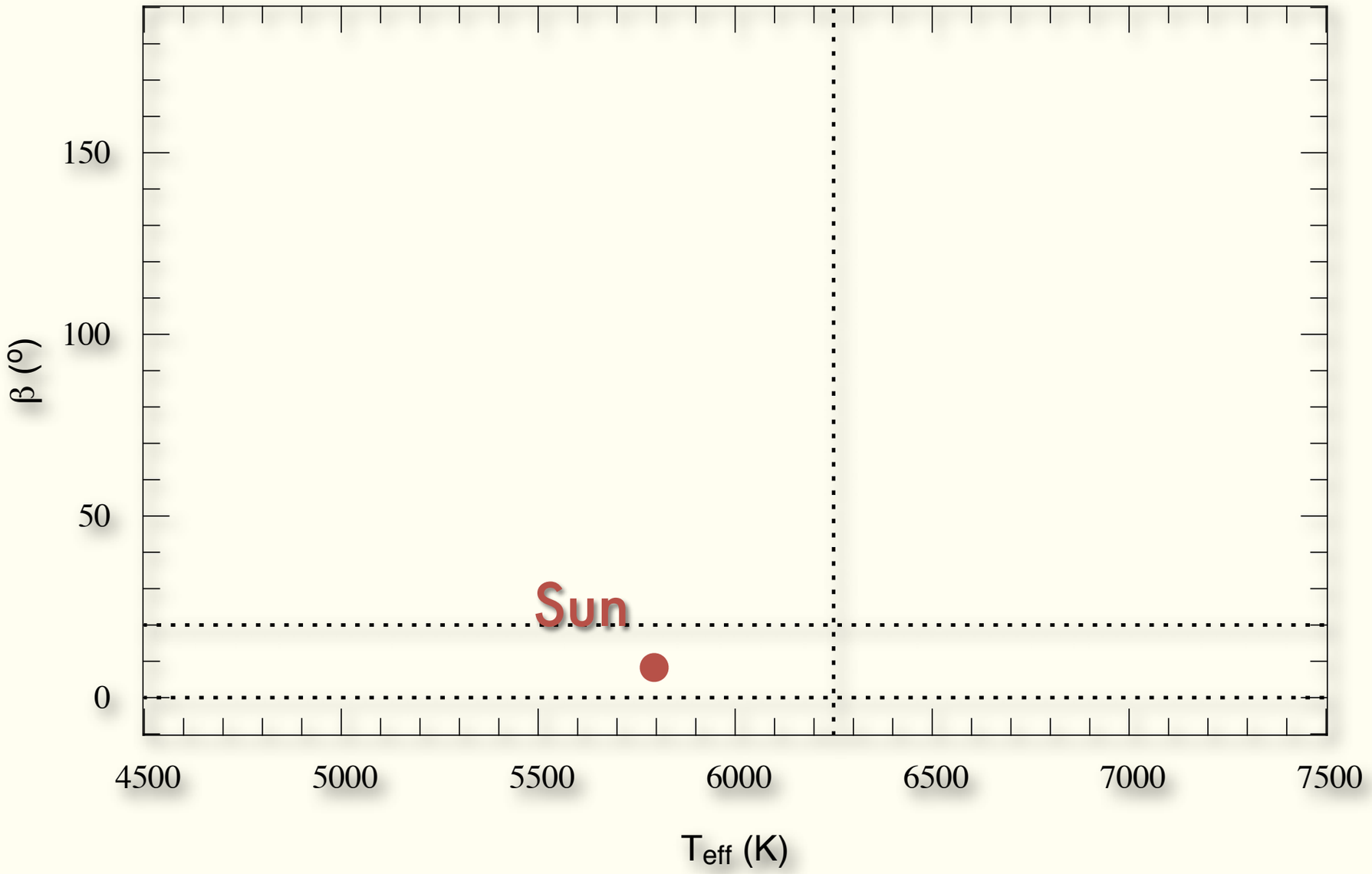

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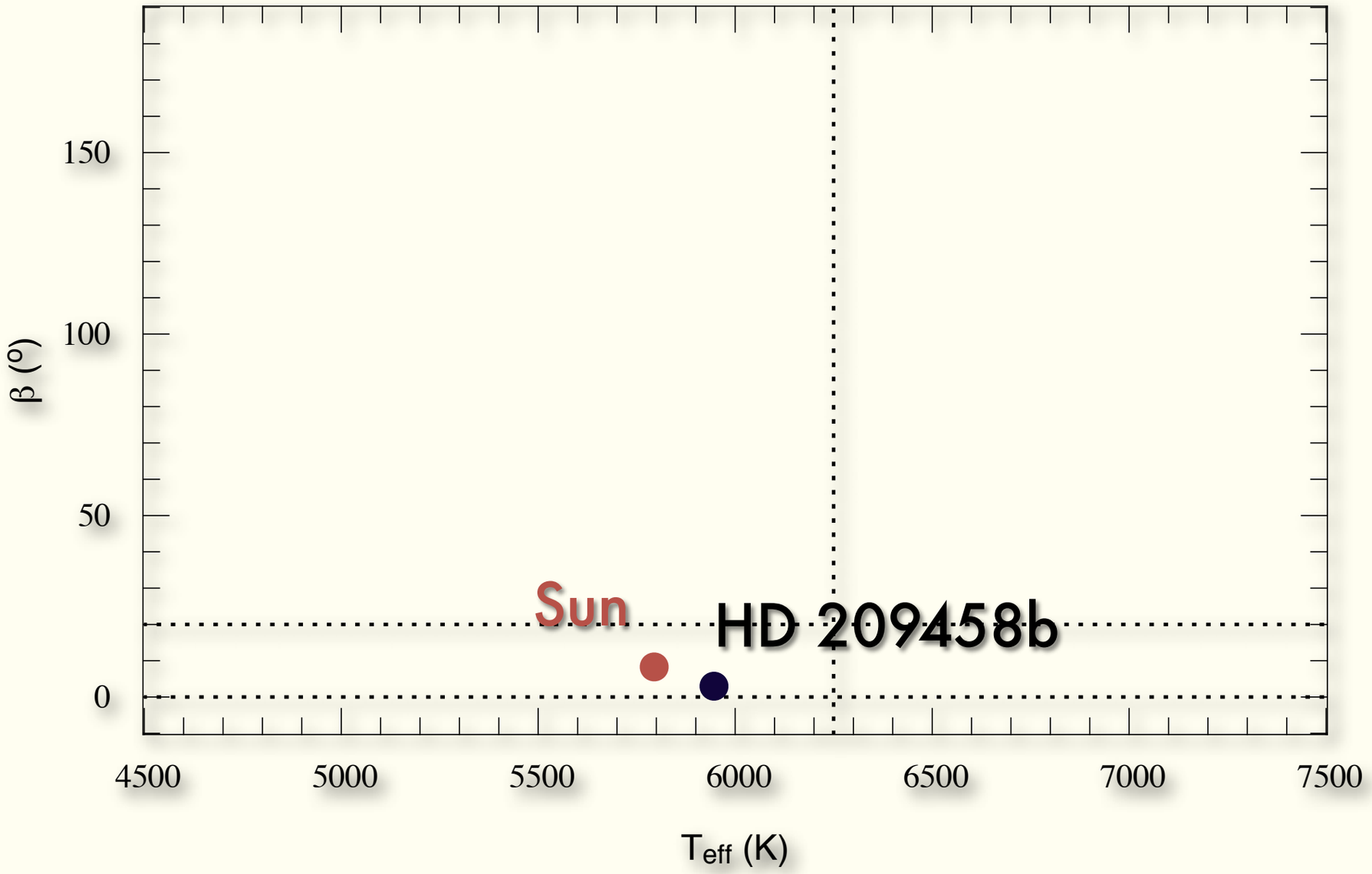

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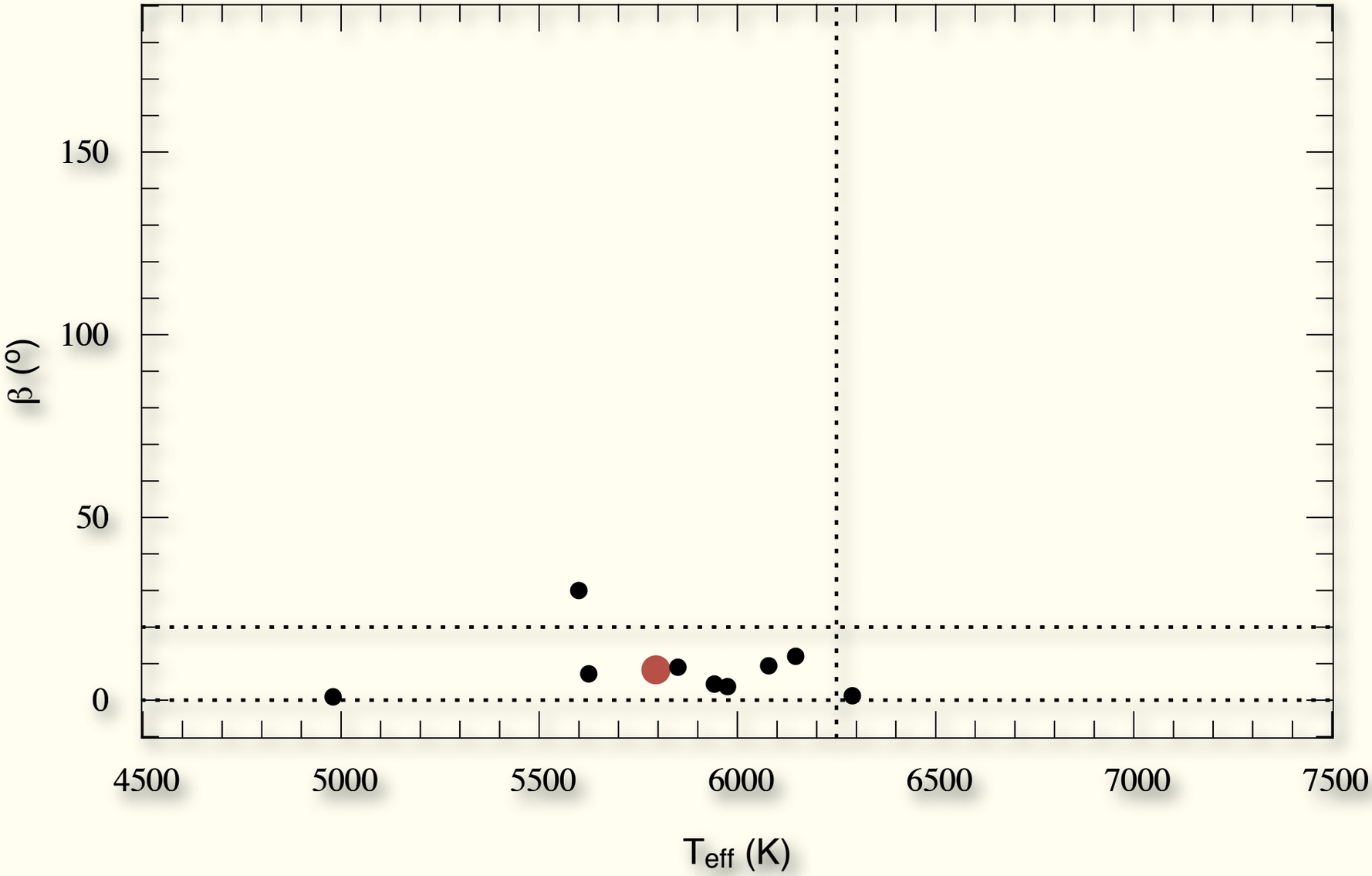

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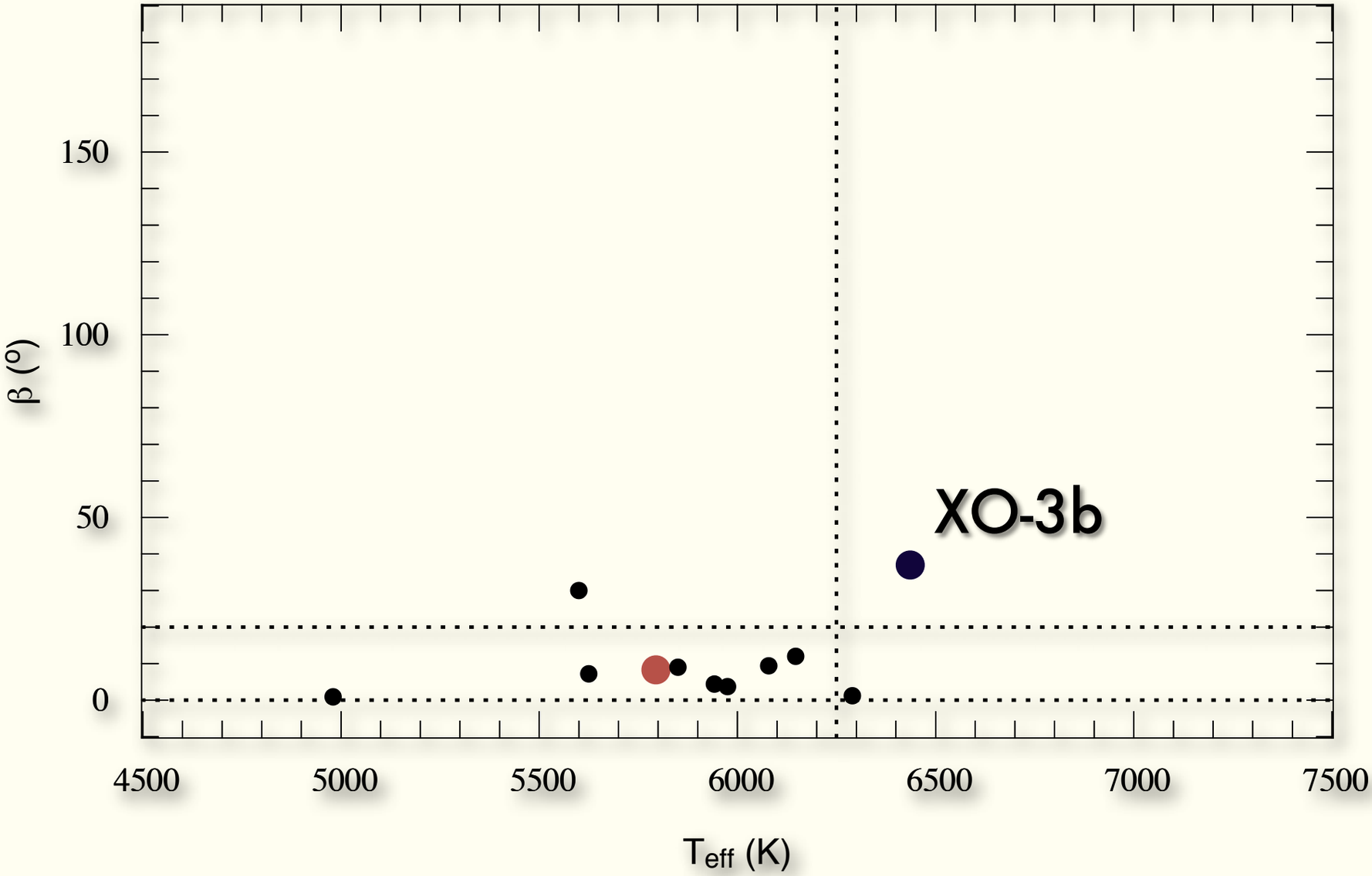

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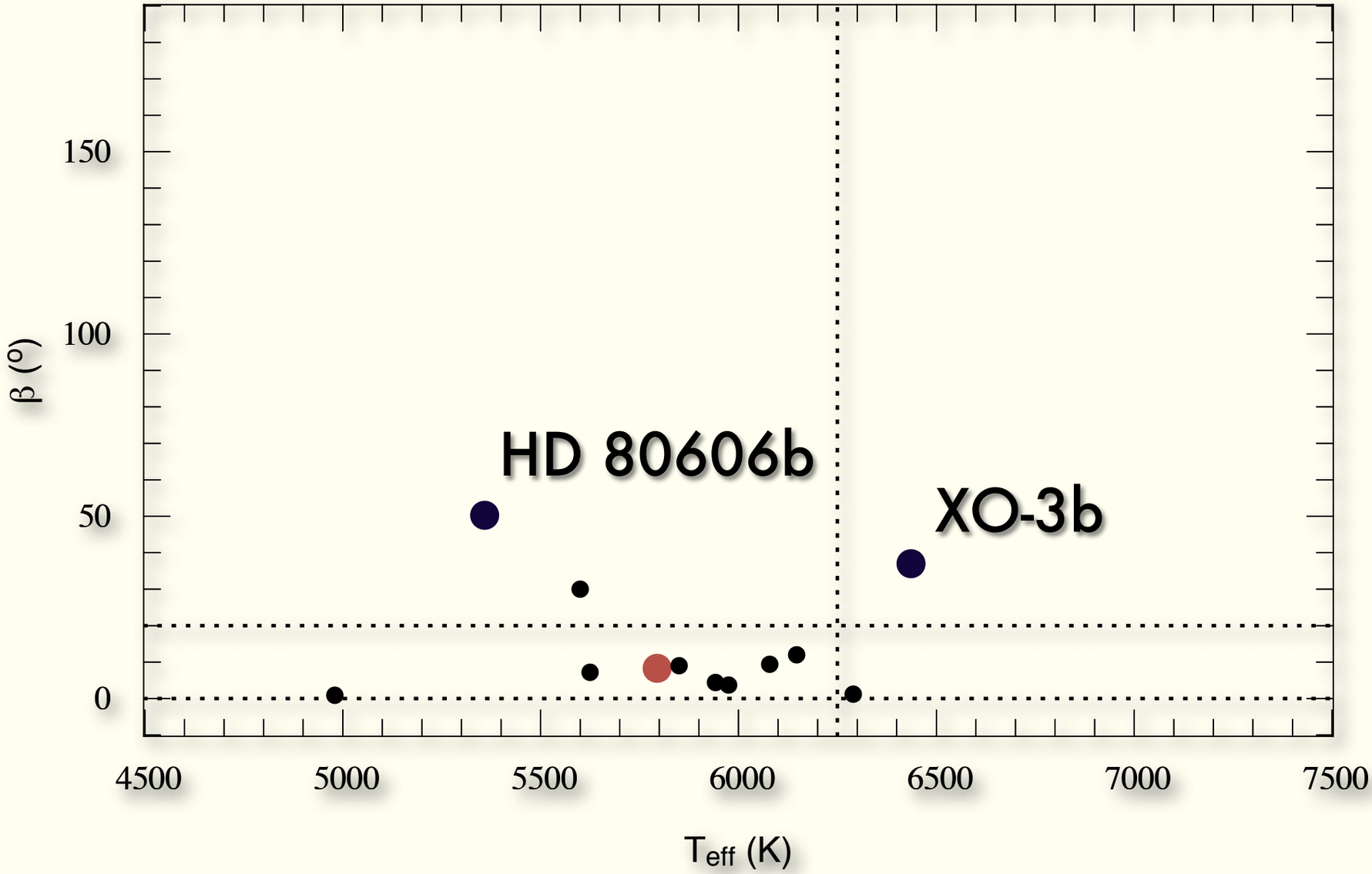

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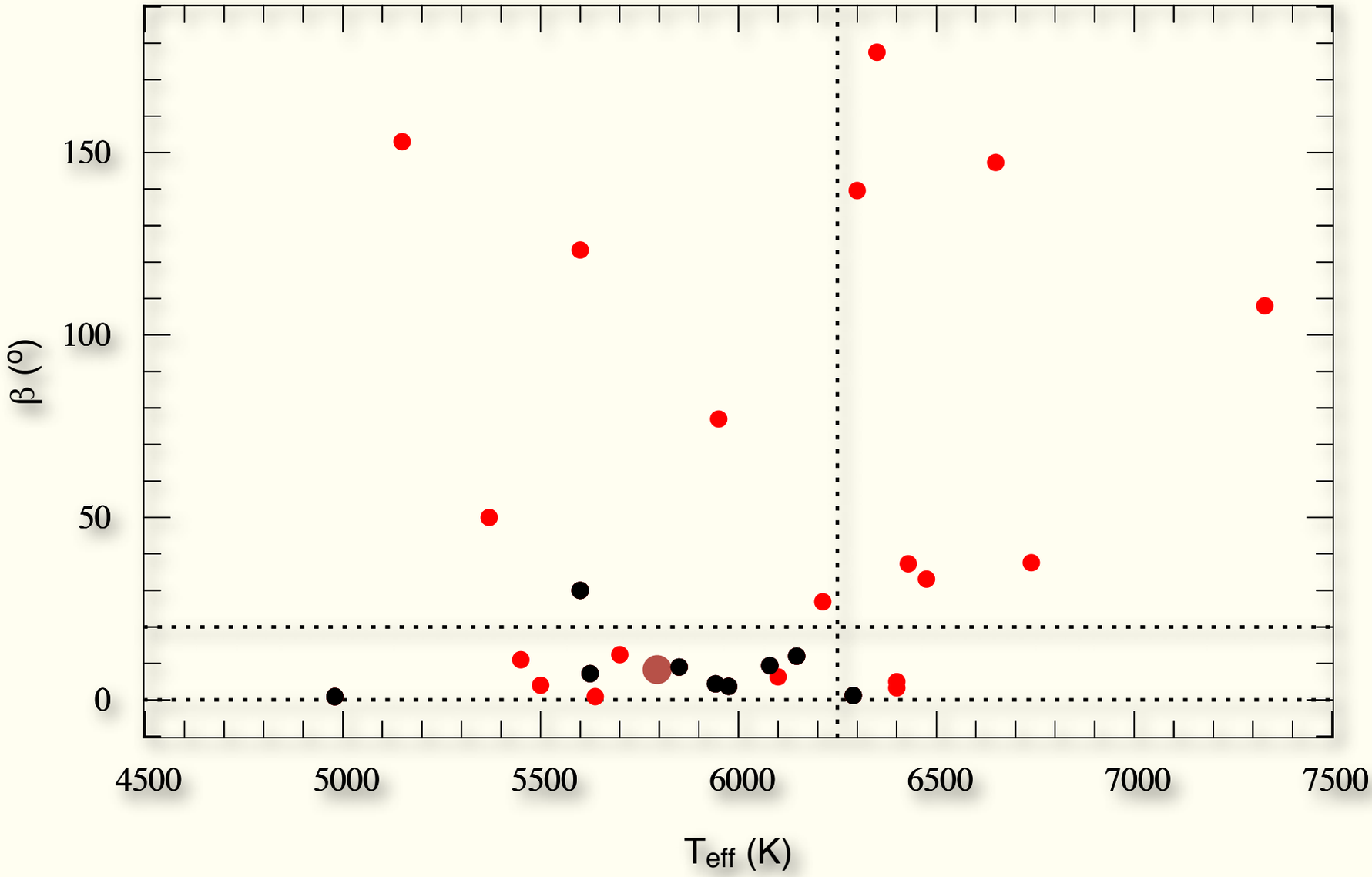

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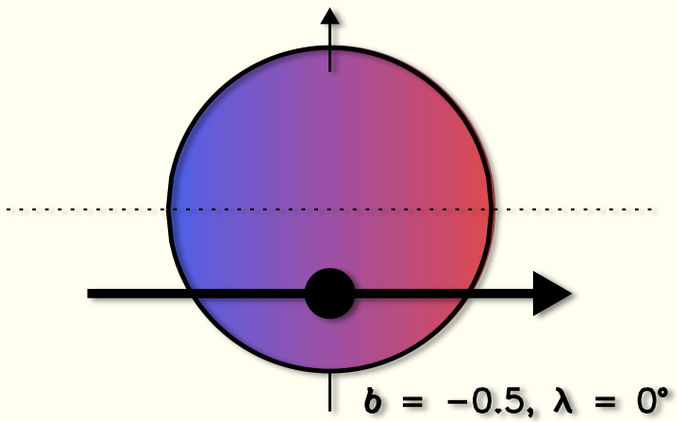
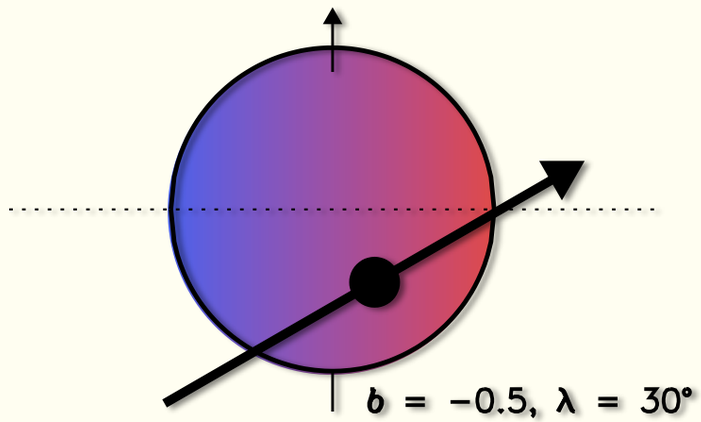
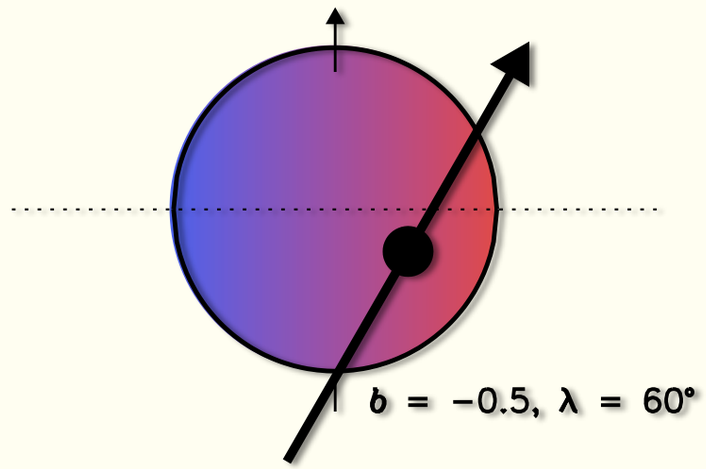
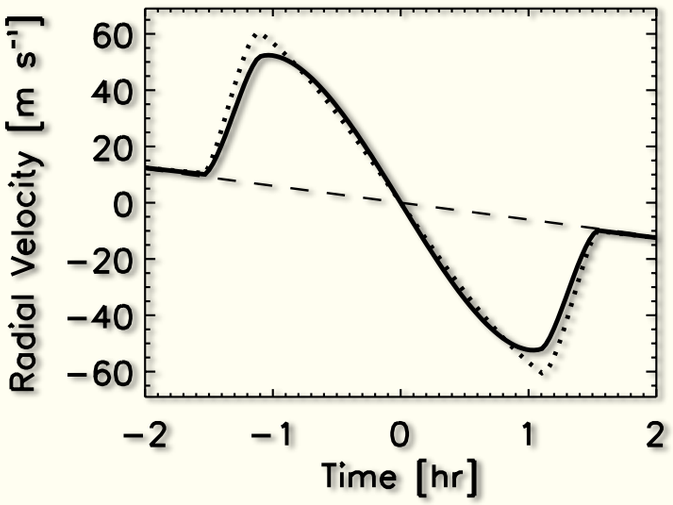
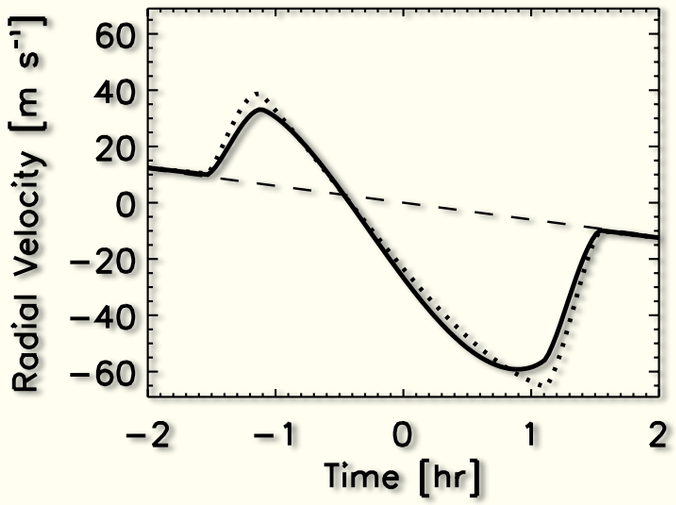
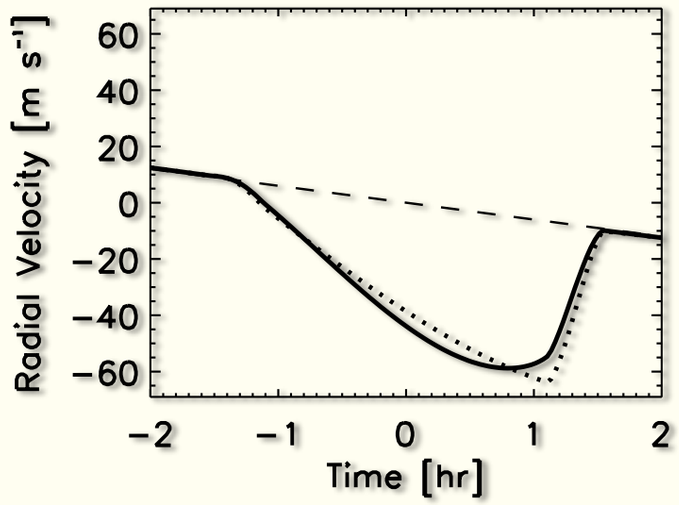






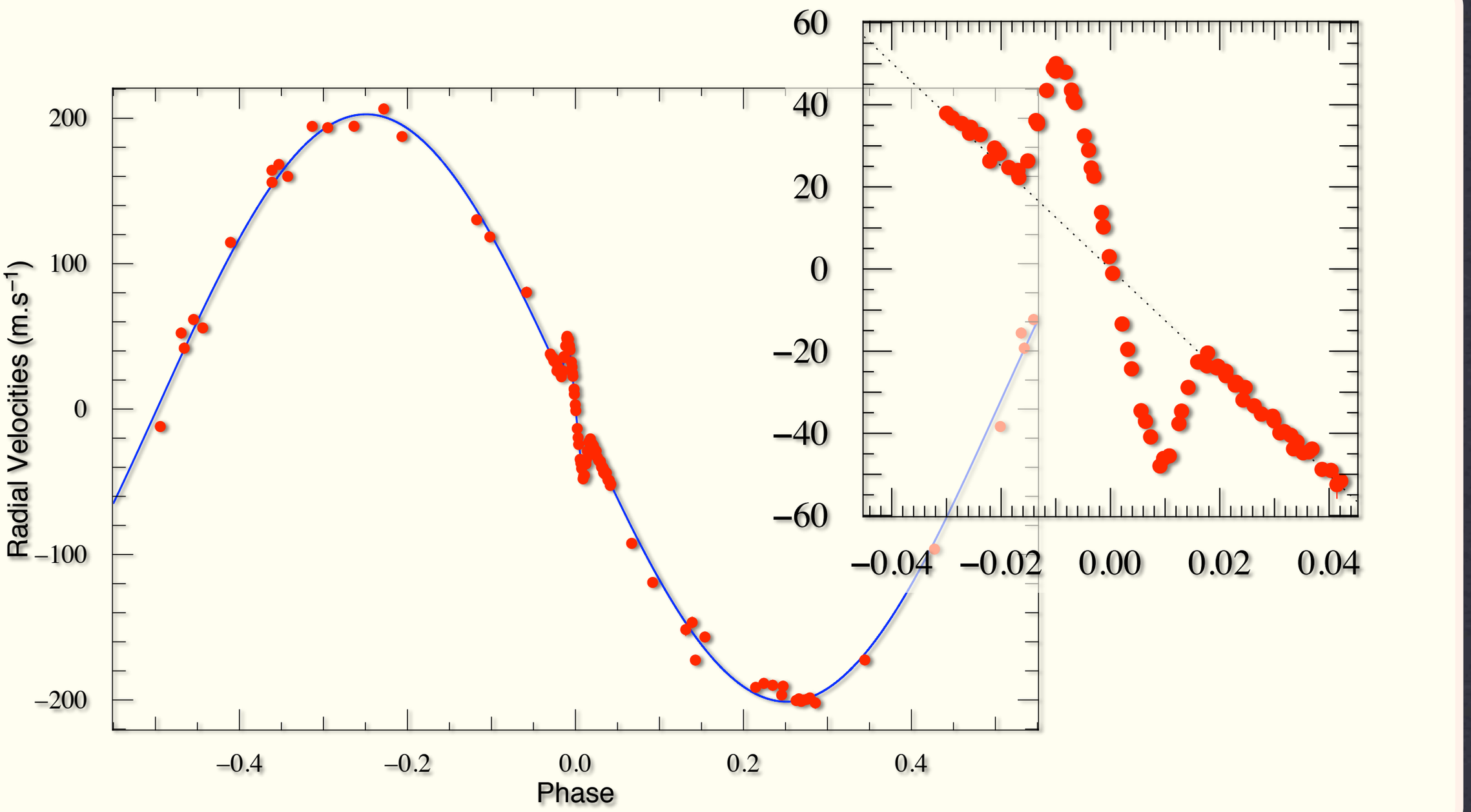






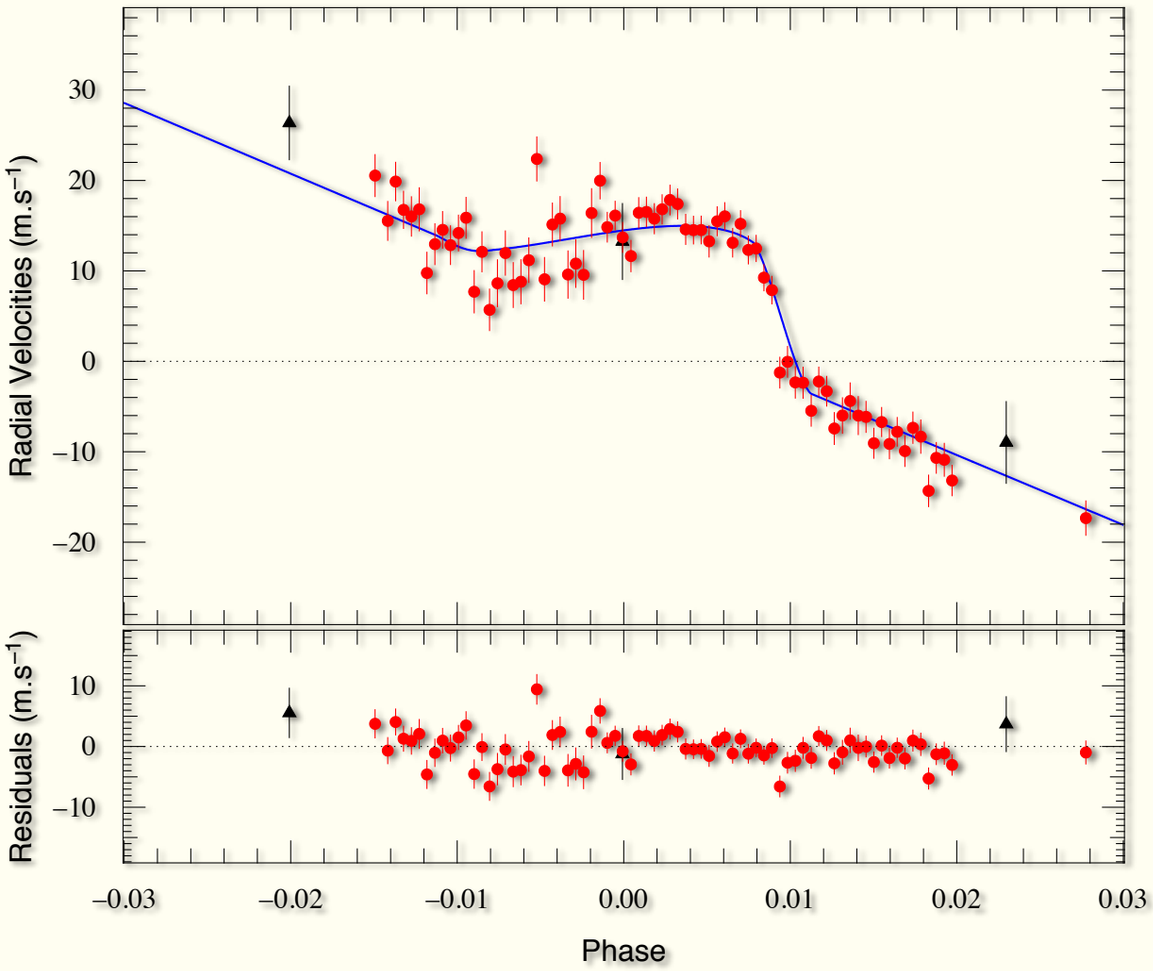
The Rossiter-McLaughin effect
In function of the spin/orbit angle, the shape changes
we only measure the projected spin/orbit angle

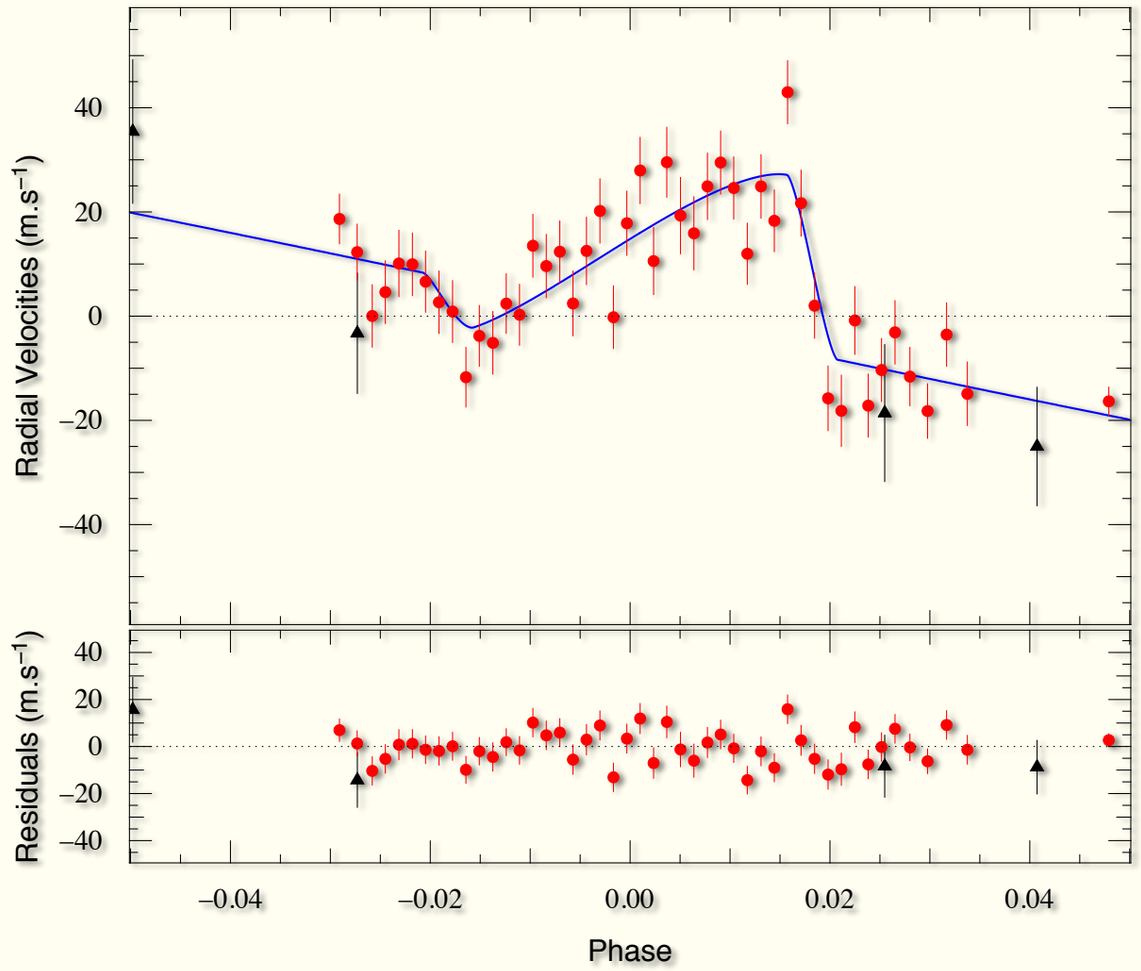
$\beta = -\lambda$	GAUDI & WINN 2007



The Rossiter-McLaughlin effect superimposed itself above the Doppler reflex motion caused by the planet on its star.
V sin I is also directly measured

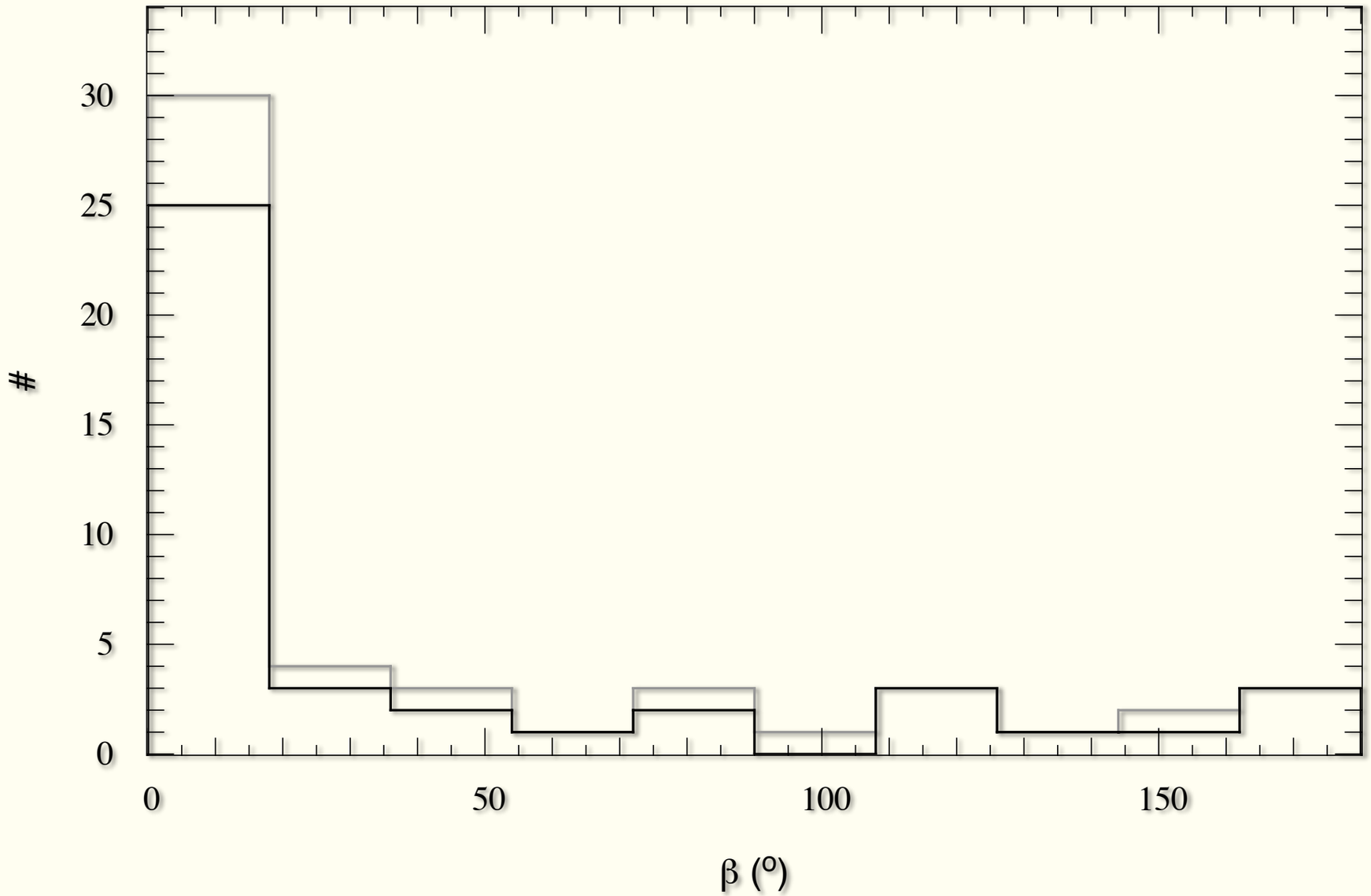
HD 189733B	TRIAUD ET AL. 2009





Some of the incriminating evidence

QUELOZ ET AL. , TRIAUD ET AL. 2010

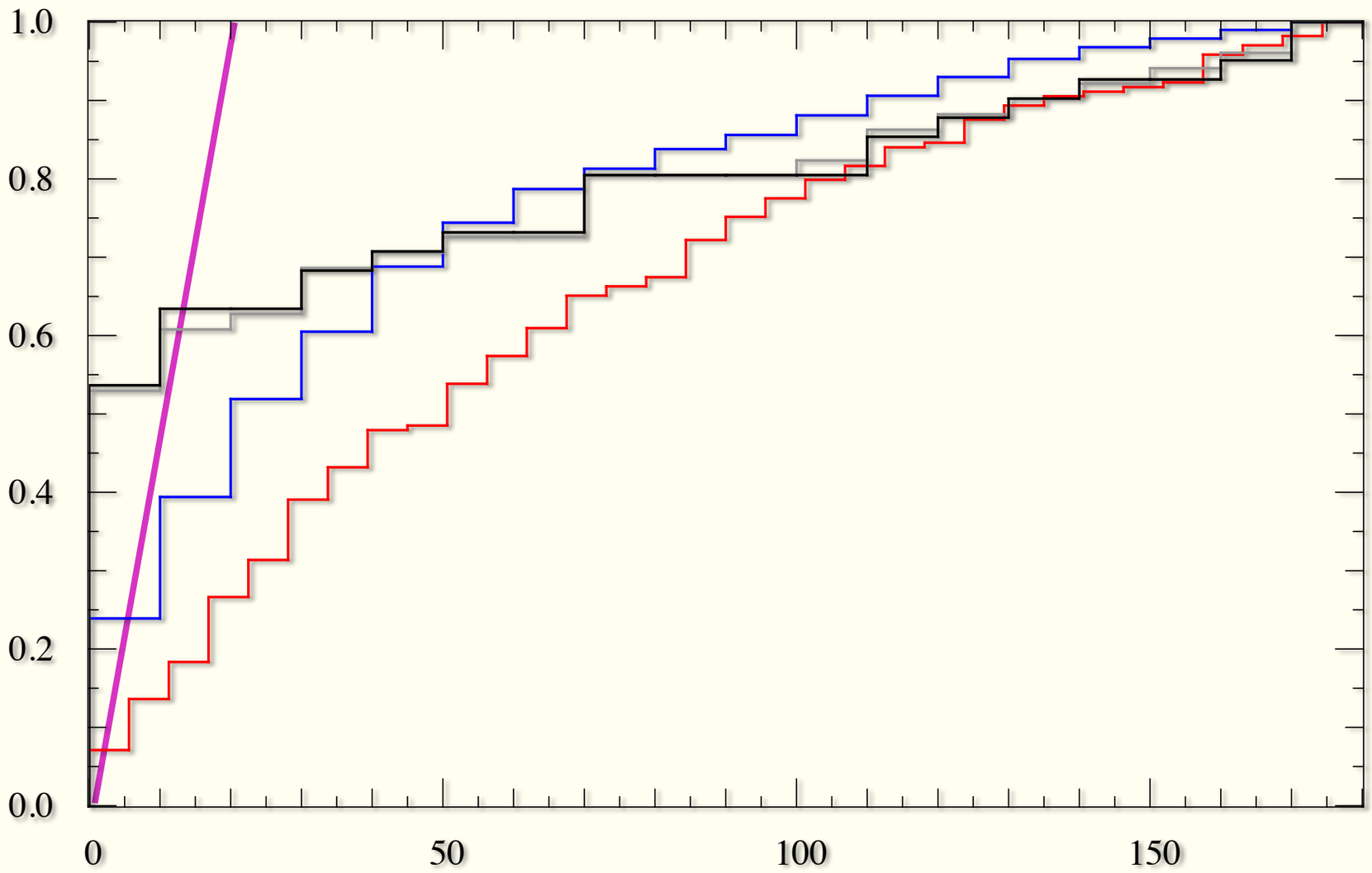


histogram of β, projected spin-orbit angle

A year ago: 26 measurements

Now: 41 measurements (+10 unsure)

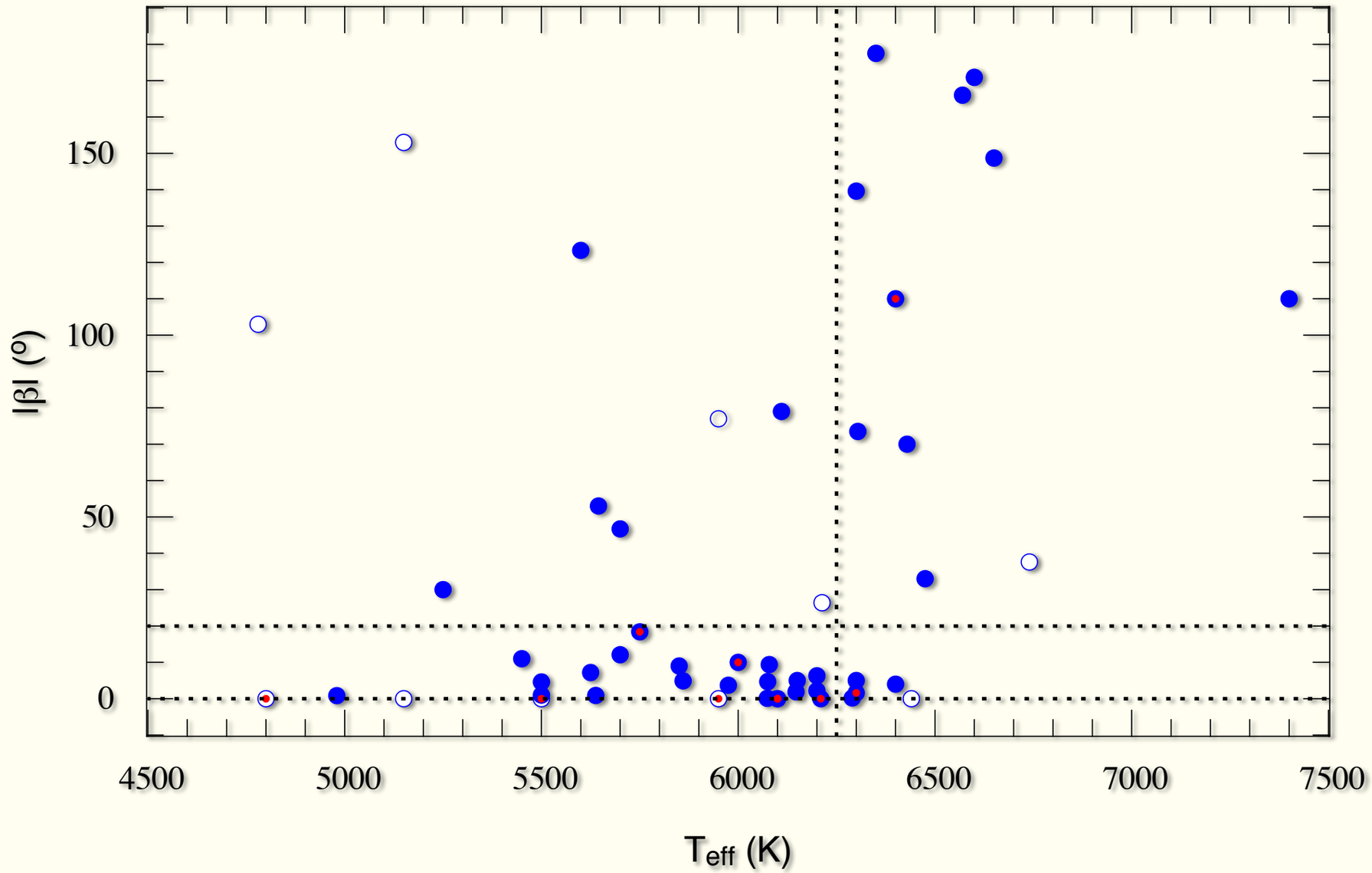
UPDATED FROM | TRIAUD, CAMERON, QUELOZ ET AL. 2010



$$\tan\beta \simeq \tan\psi \sin\alpha$$

Transform theoretical ψ to β
Theory predicts about 55% of planet should appear aligned
2 theories: Fabrycky & Tremaine ’07, Nagasawa et al ’08

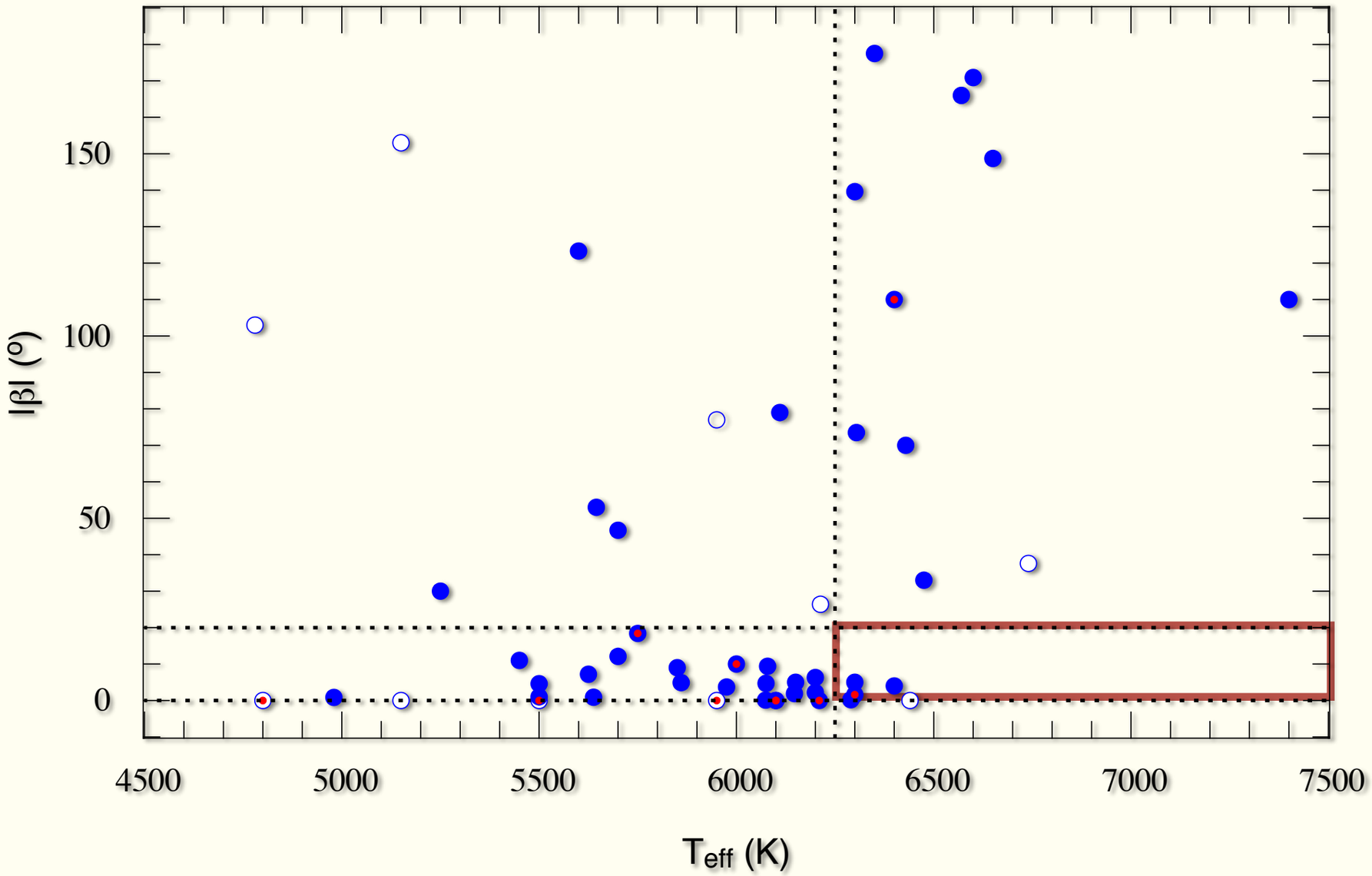
UPDATED FROM | TRIAUD, CAMERON, QUELOZ ET AL. 2010



At Teff=6250K the outer stellar convective layer disappears
results confirmed independently by Schlaufman ‘10
realignement depends on: Mp, Mcz (or M★), e, a... (Q?)

NUMBERS LIKELY TO CHANGE

WINN ET AL 2010 & VARIOUS PAPERS



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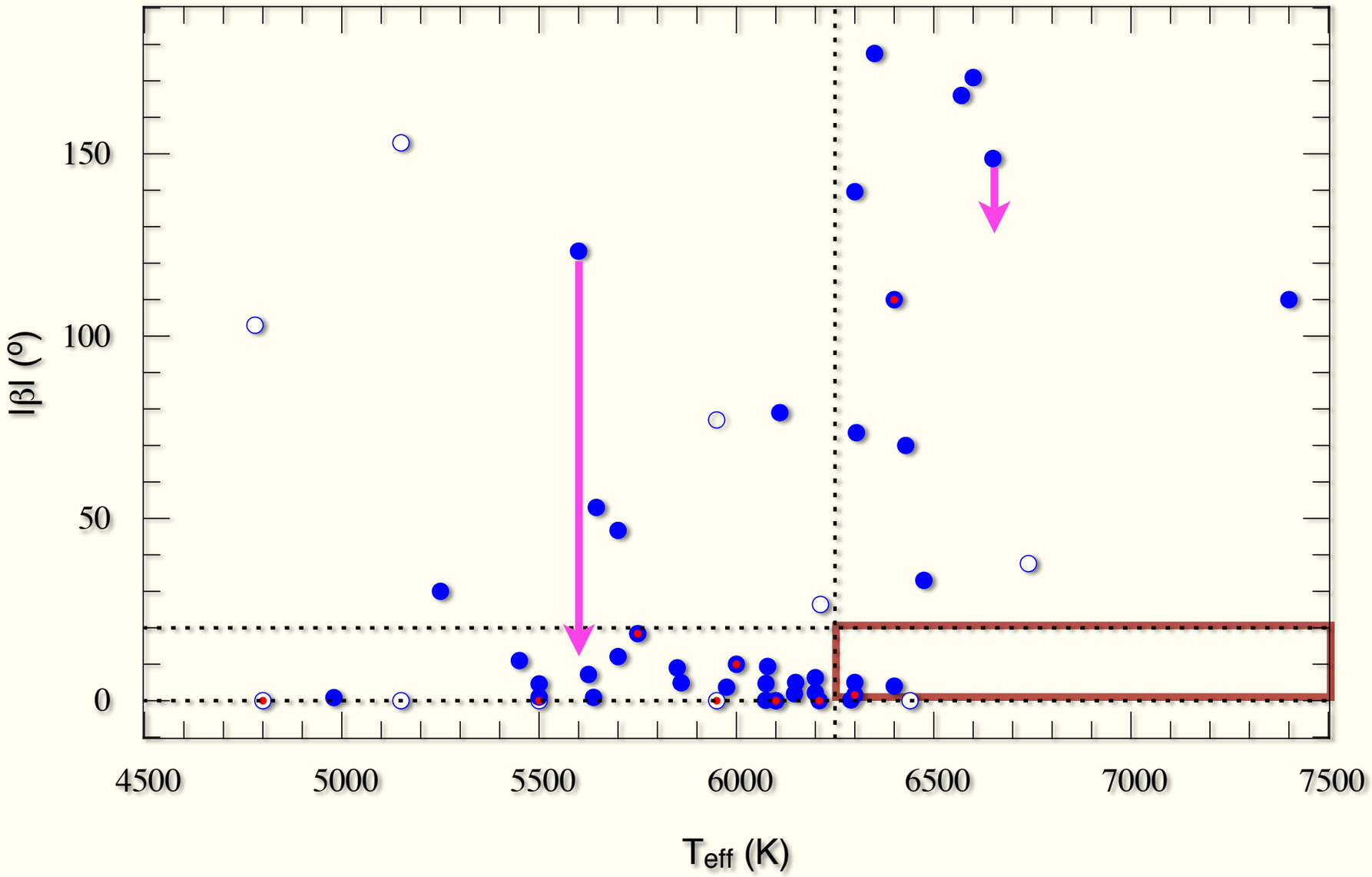

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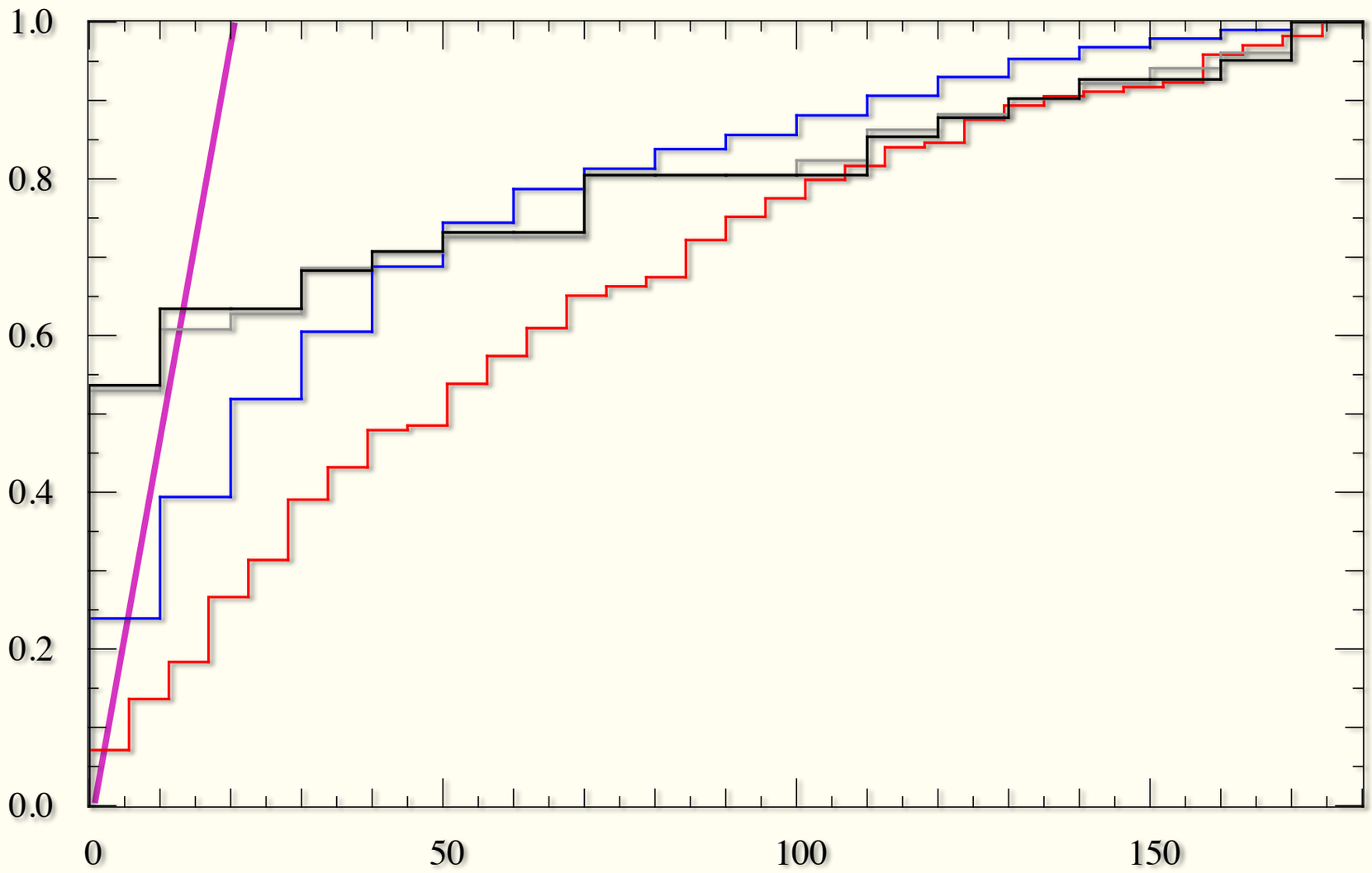

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Take only planets on the «hot» side

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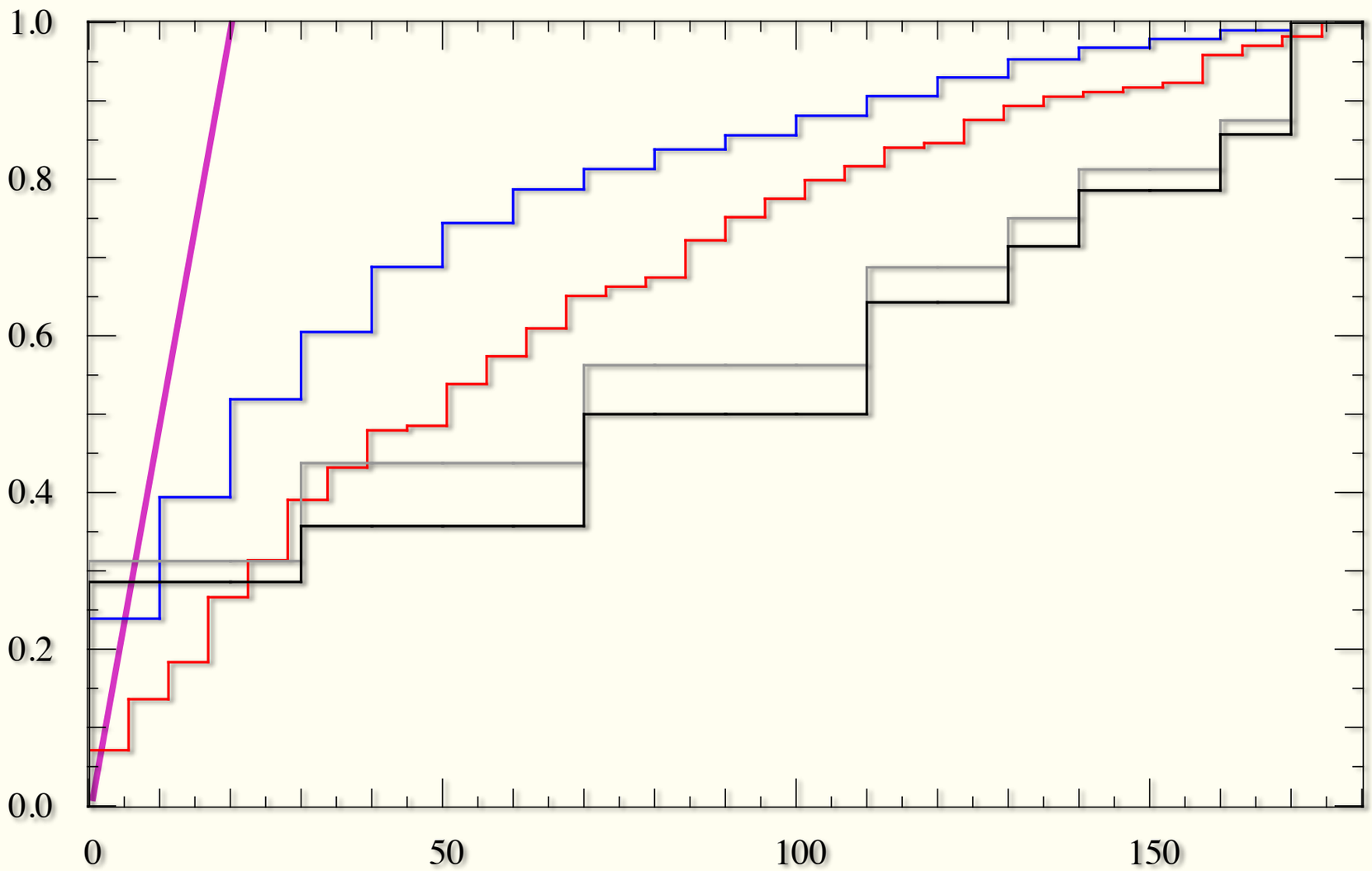

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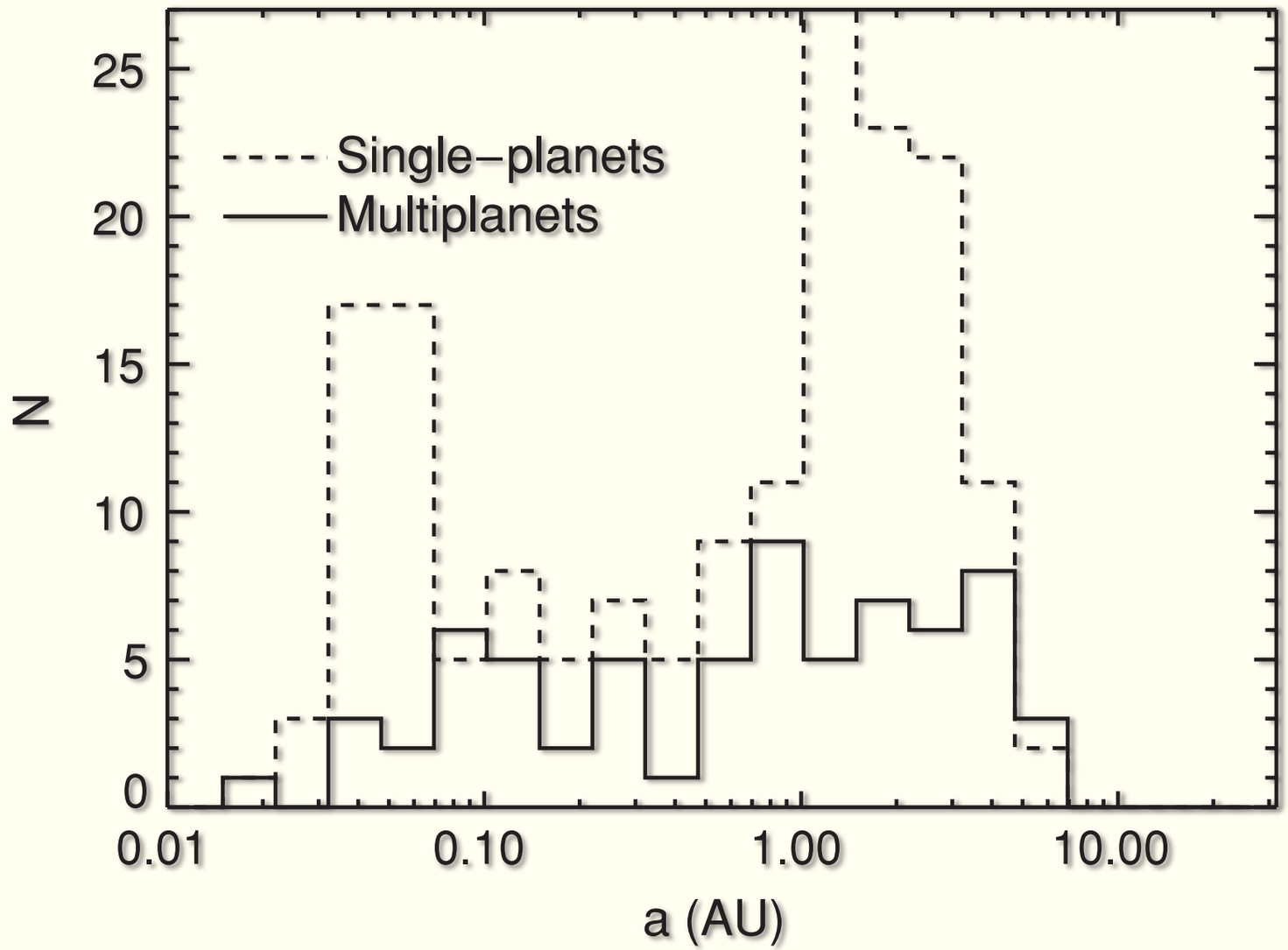

multiple systems ≠ single planet systems

migrating? ≠ dynamic systems

Hot Jupiter: why so lonely?

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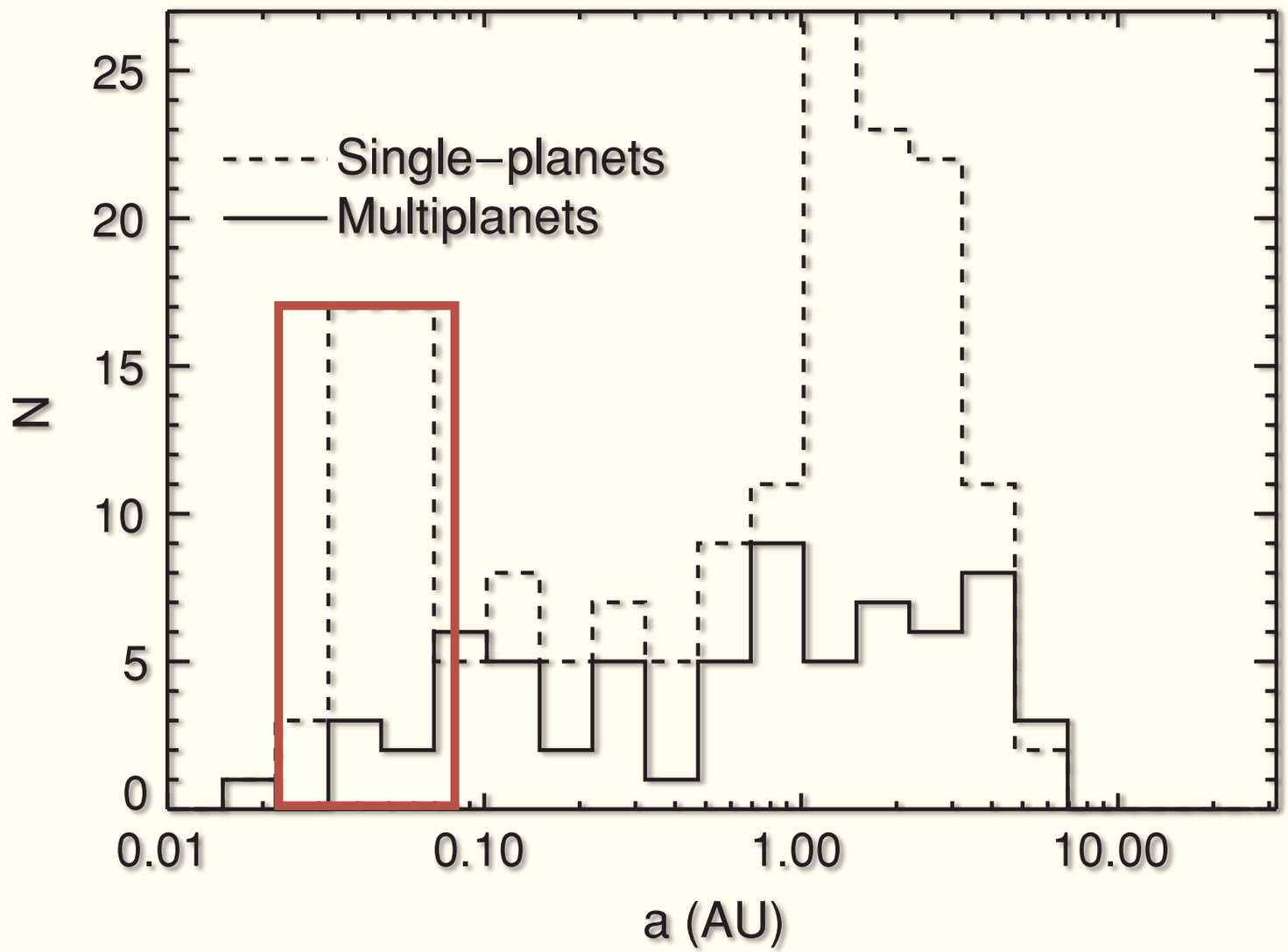
Violent Dynamics & Tidal friction



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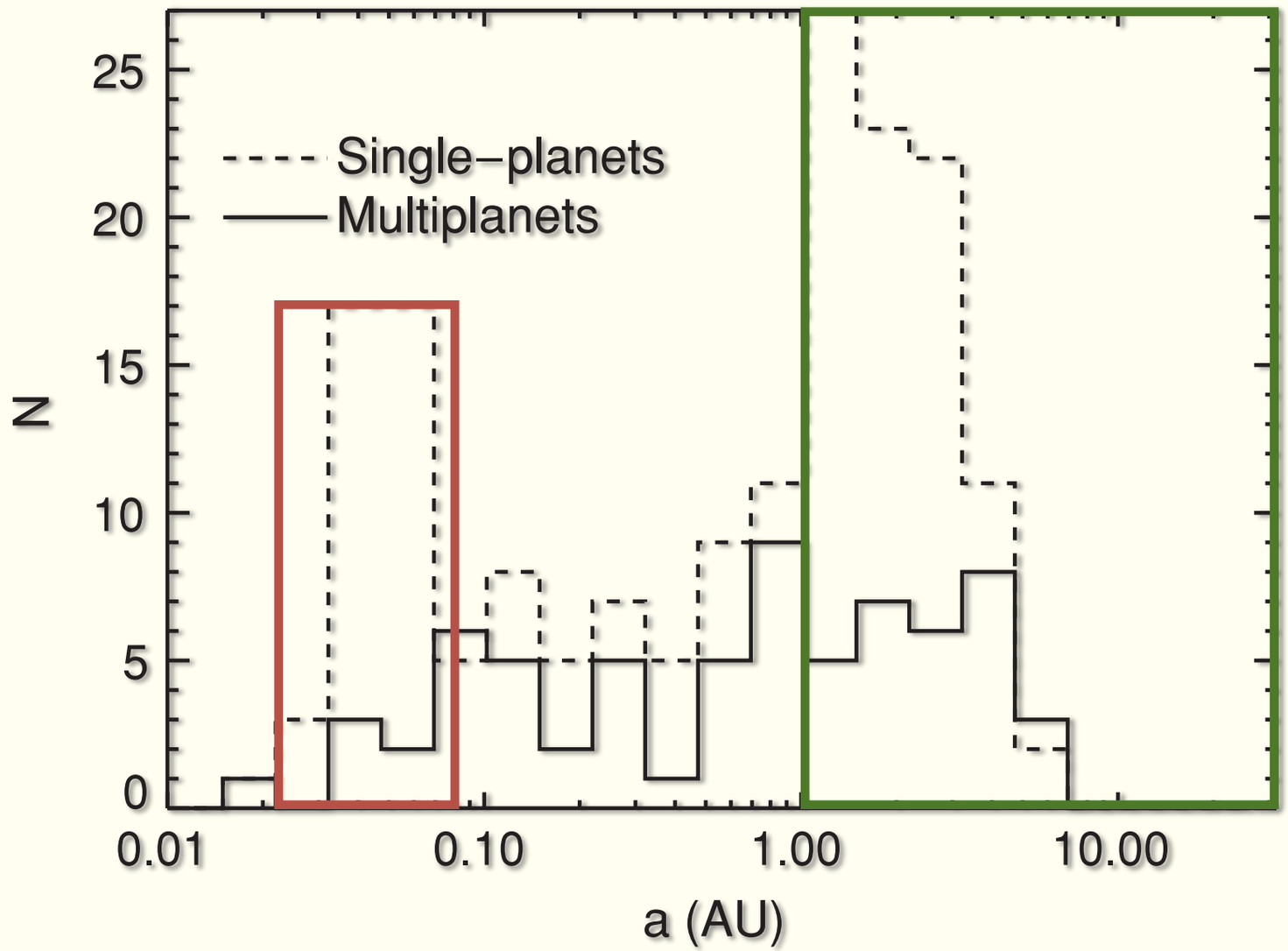

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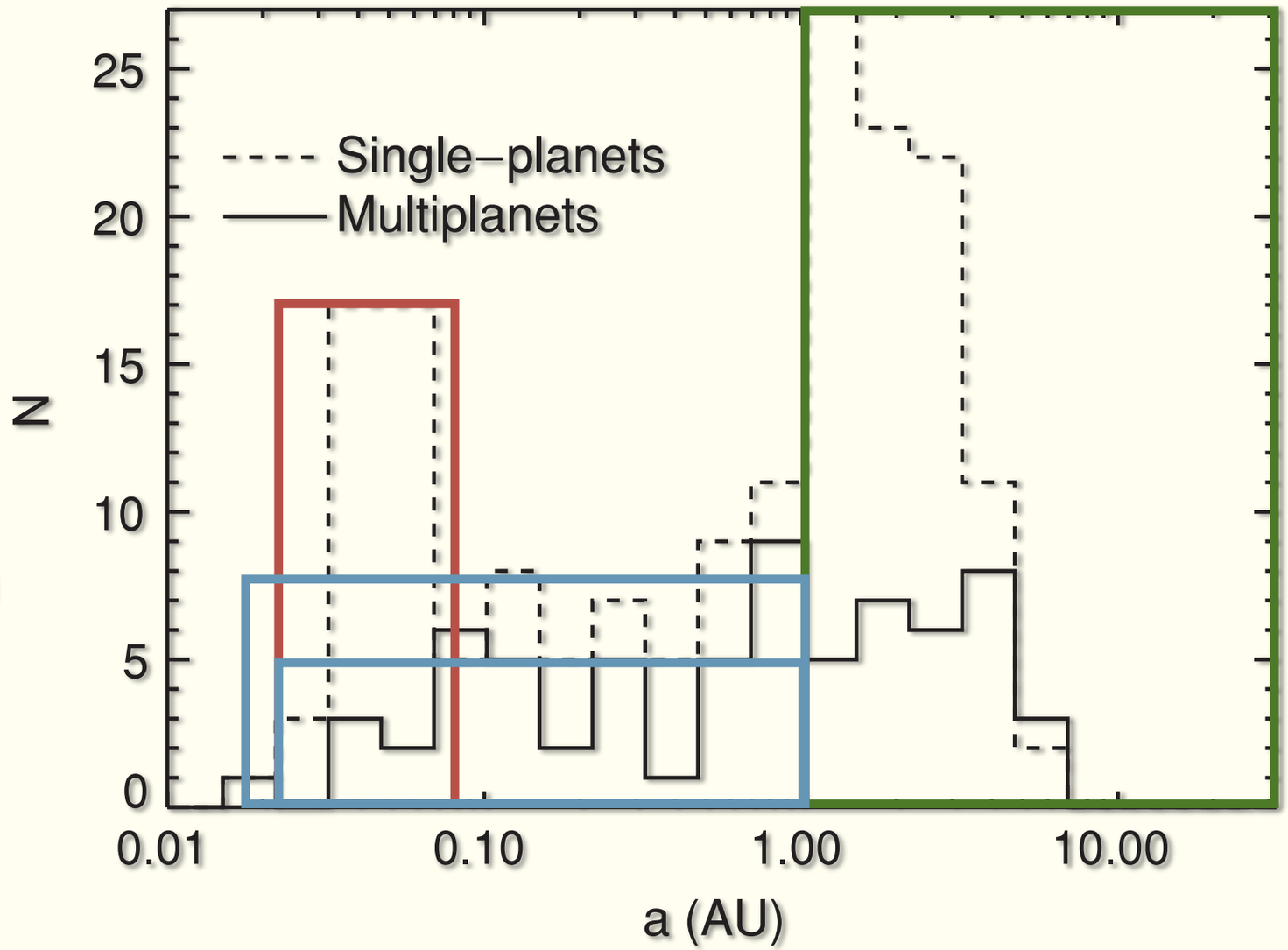

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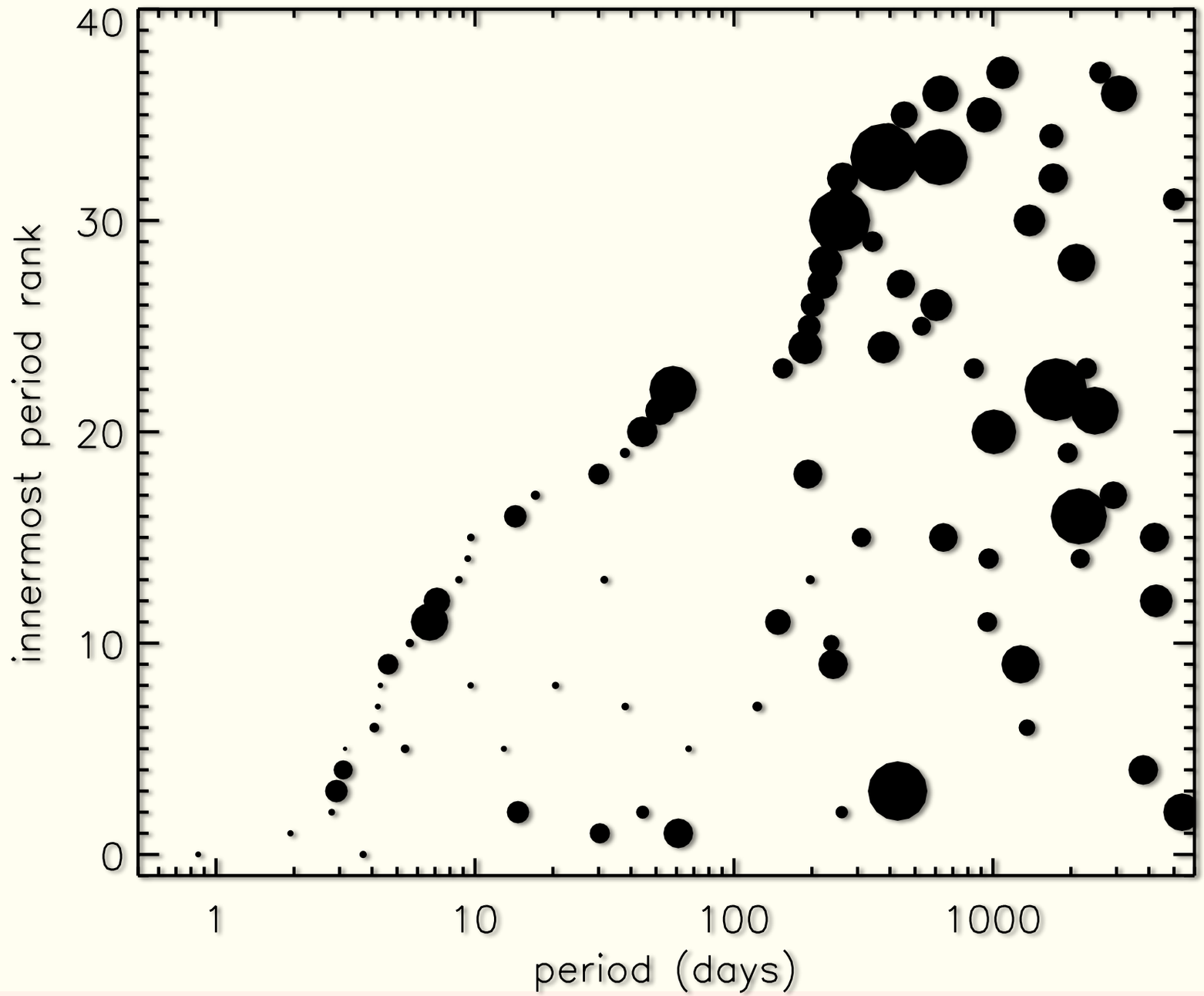
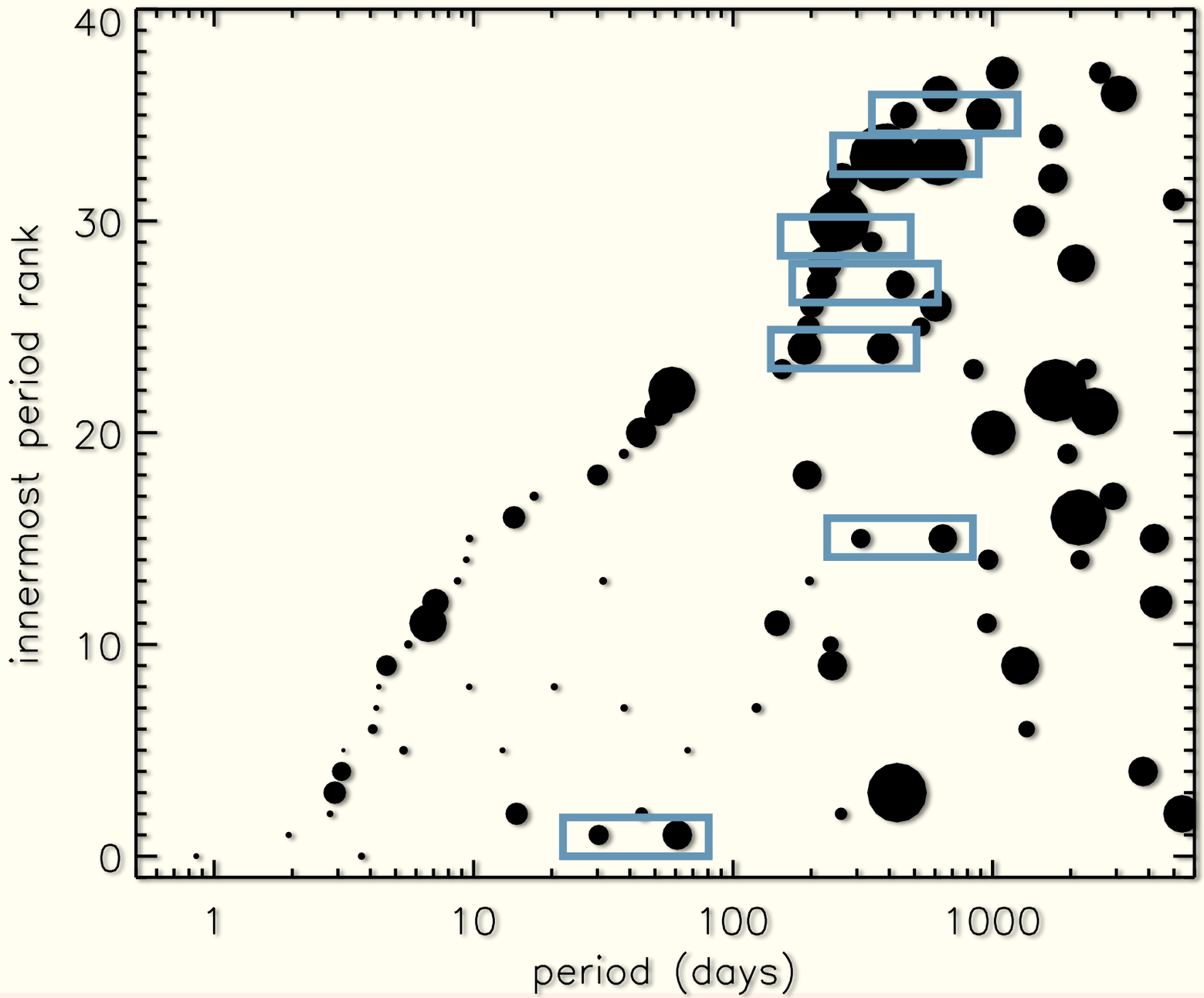


Resonances in multi planetary systems are not everywhere

DISC MIGRATION | FROM DAN FABRYCKY



Resonances in multi planetary systems are not everywhere

DISC MIGRATION | FROM DAN FABRYCKY

POINTS TOWARDS A DYNAMICAL ORIGIN FOR MOST HOT JUPITERS
≈ 1 STAR IN 150

TIDES ARE IMPORTANT: DEPEND ON THE STAR & THE PLANET
GIVE THE TIDAL MIGRATION & REALIGNMENT TIMESCALES

A CALL TO WORRY ABOUT THE STELLAR ENVIRONMENT OF PLANETARY FORMATION (FLY-BYS, BINARY FORMATION AND DESTRUCTION)

Interesting consequences: fewer Hot Jupiters around young star
no small planet outside HJ, doing TTV
a population of lone eccentric Jupiters

REFLECTIONS

DYNAMICS DO NOT CARE ABOUT ABSOLUTE MASSES BUT MASS RATIOS

AROUND M DWARVES:

SMALL DISCS => SMALLER PLANETS => SAME DYNAMICS

GJ436B & GJ1214B: MISALIGNED?

WASP30B AND COROT15B

(AROUND MORE MASSIVE STARS)

NEEDED A SYSTEM OF BROWN DWARFS?

(NON HOT JUPITER) PLANETS TO FAR TO REALIGN:

COROT-4B, COROT-9B: (SMALL ECC, ALIGNED?)

High mass ratio close binaries are supposed to form via Kozai

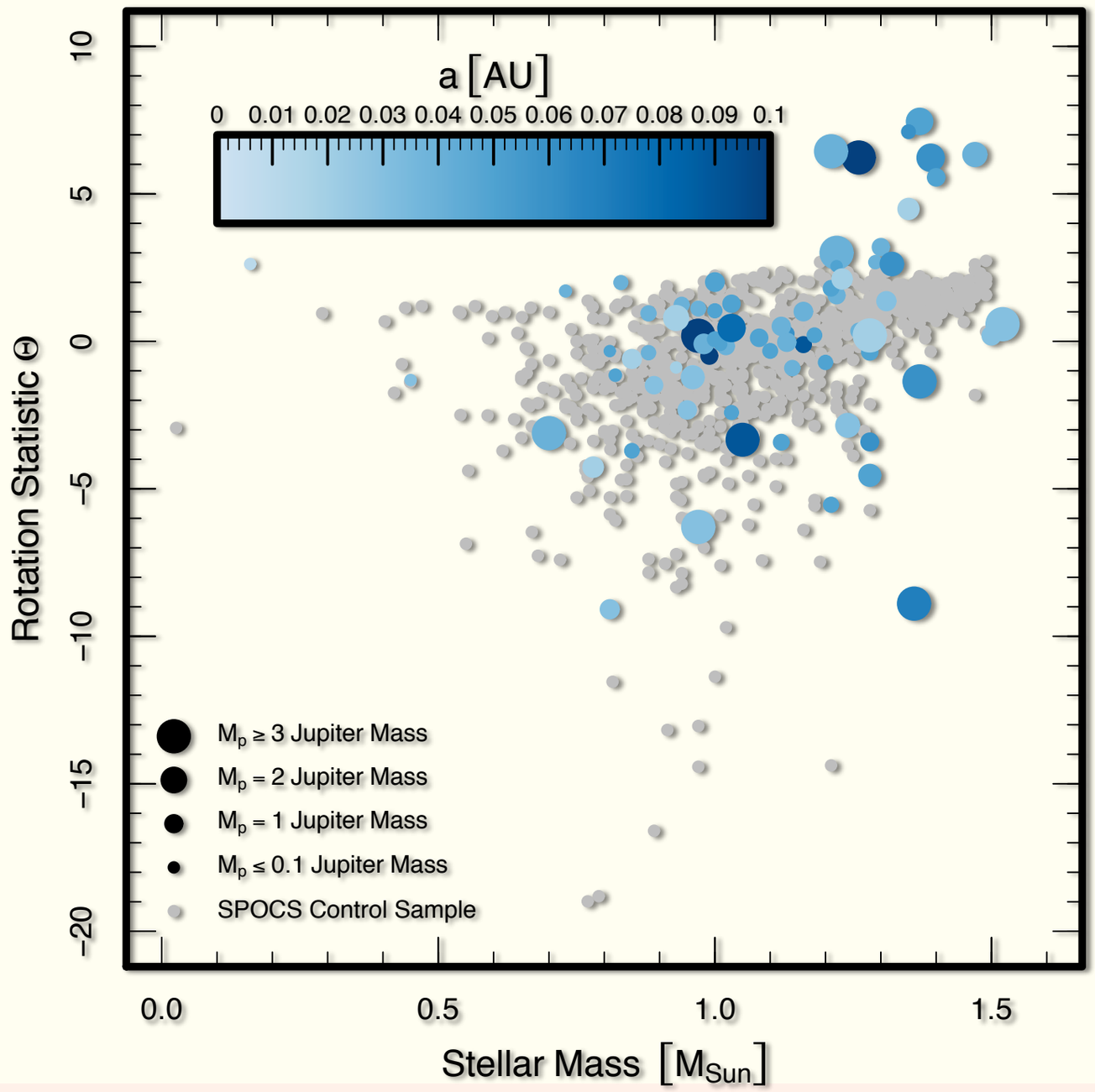
We also observed the Rossiter-McLaughlin effect

on 15+ M dwarfs transiting G & F dwarfs: all aligned

REFLECTIONS	TRIAUD ET AL. IN PREP

Results here thanks to the work of many teams including my own: the WASP consortium (Anderson,Simpson, Brown, Miller, Collier Cameron, Queloz) but also: Winn, Narita, Johnson, Hébrard, Moutou....

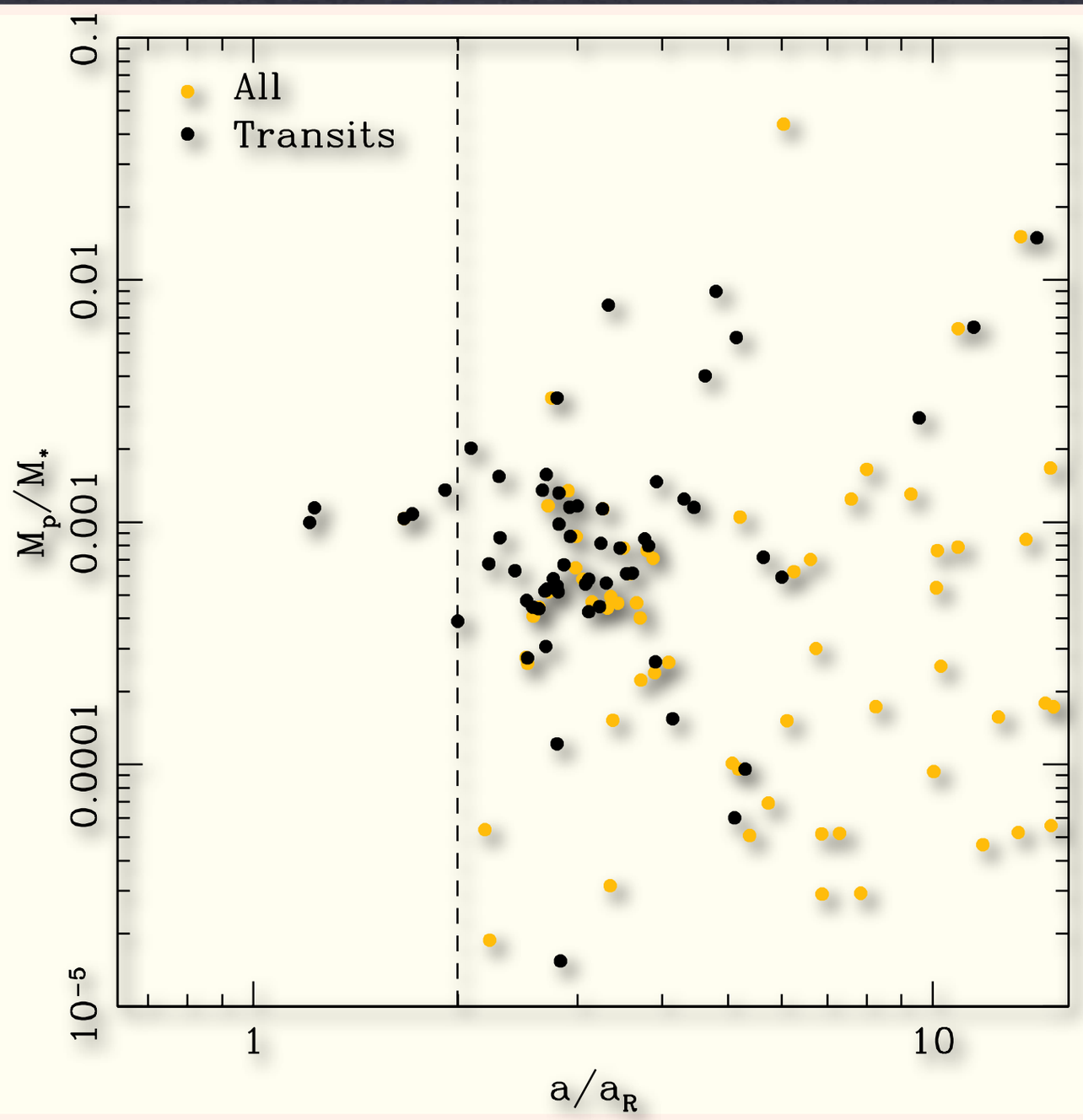
ENDWORD



Hot exoplanet host stars rotate slower than average hot star

OTHER EVIDENCE

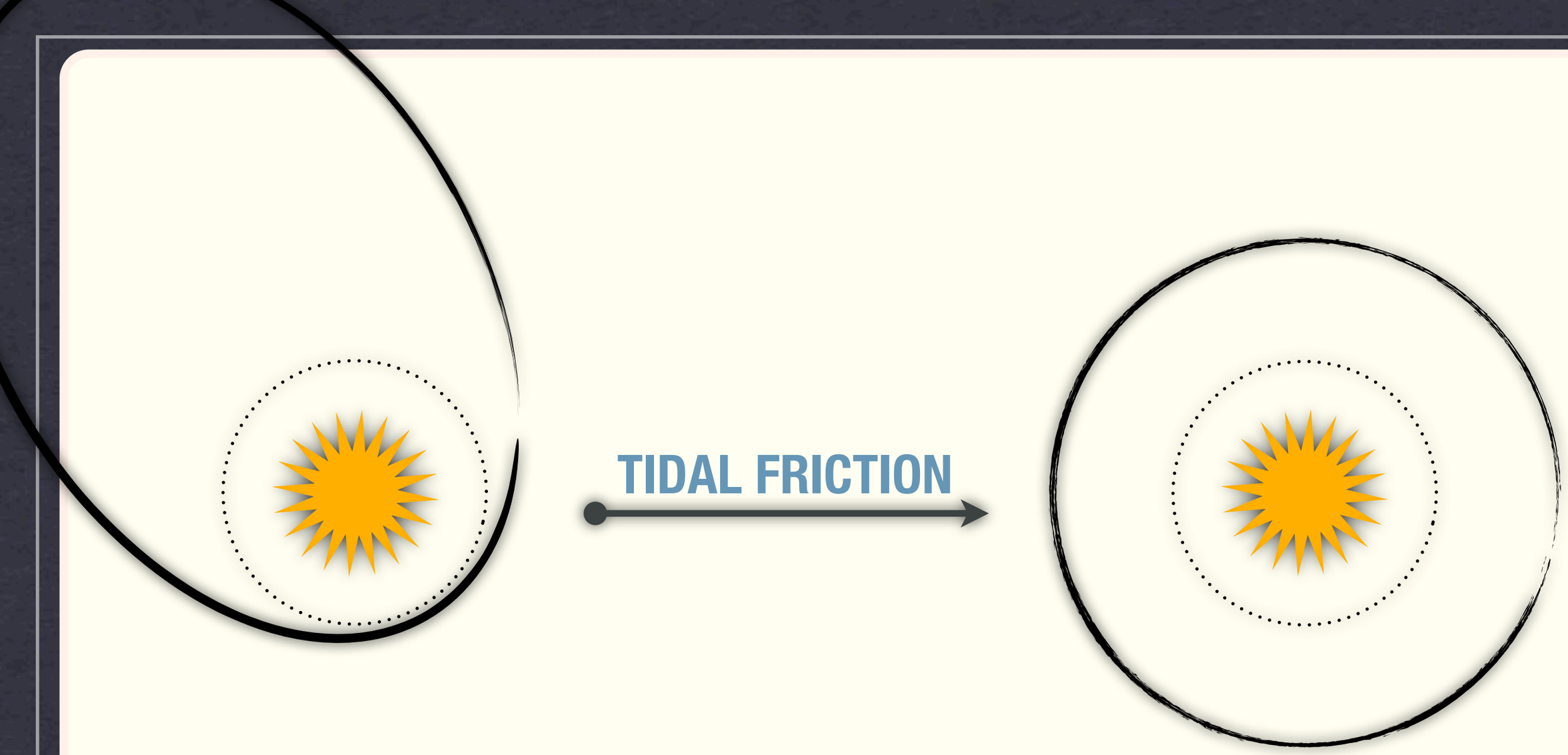
SCHLAUFMAN 2010



Most hot Jupiters are beyond 2 Roche Radii from the star

OTHER EVIDENCE

MATSUMURA ET AL. ’10, FORD & RASIO ’06



Limit of 2 Roche radii explained naturally by tidal circularisation

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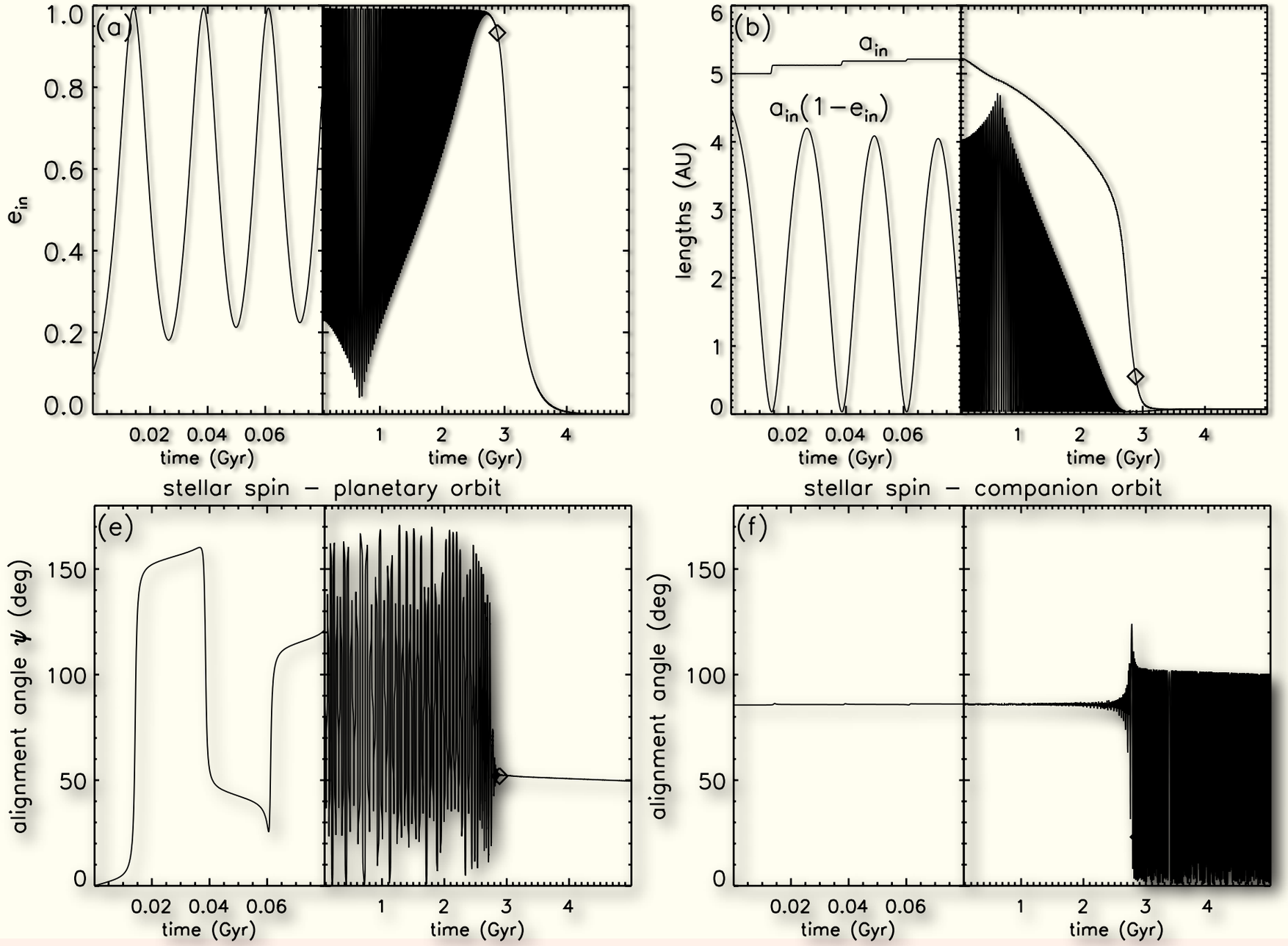
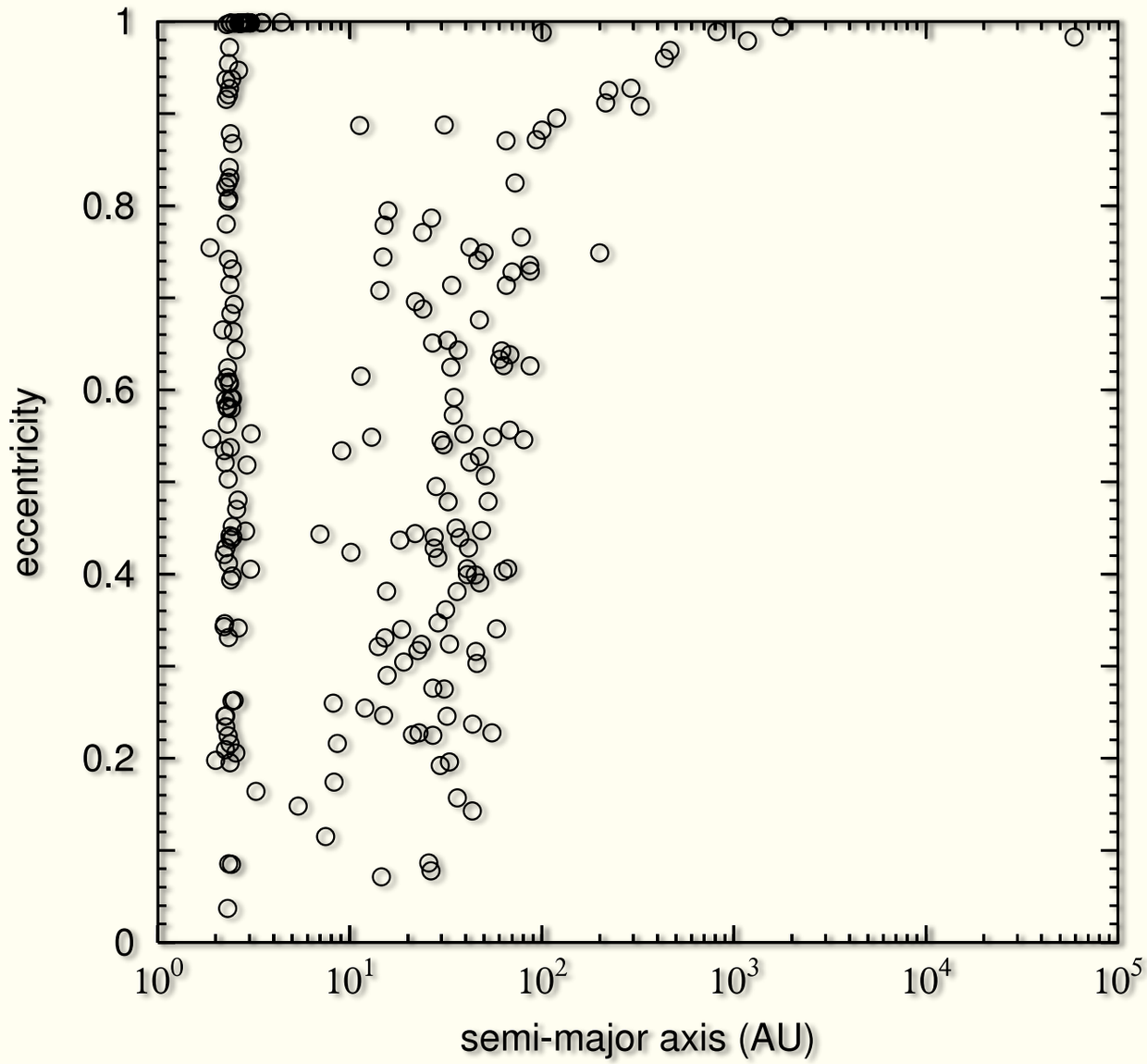


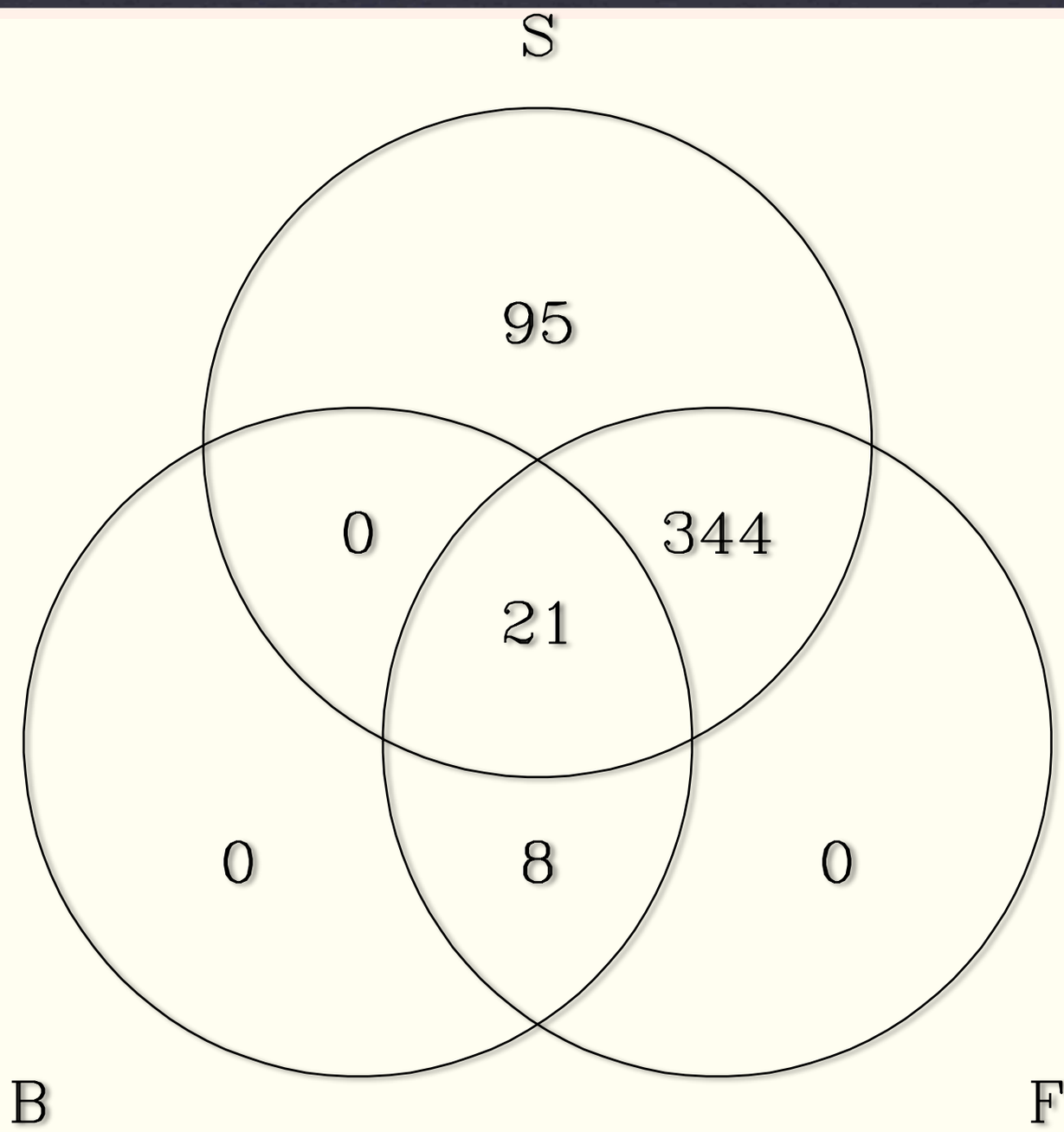
Binary is at 1000 AU, planet starts at 5 AU
produce a prediction of ψ from a simulations with
initial conditions matching binary observations

KOZAI + TIDAL	FABRYCKY & TREMAINE ‘07, WU ET AL ‘07



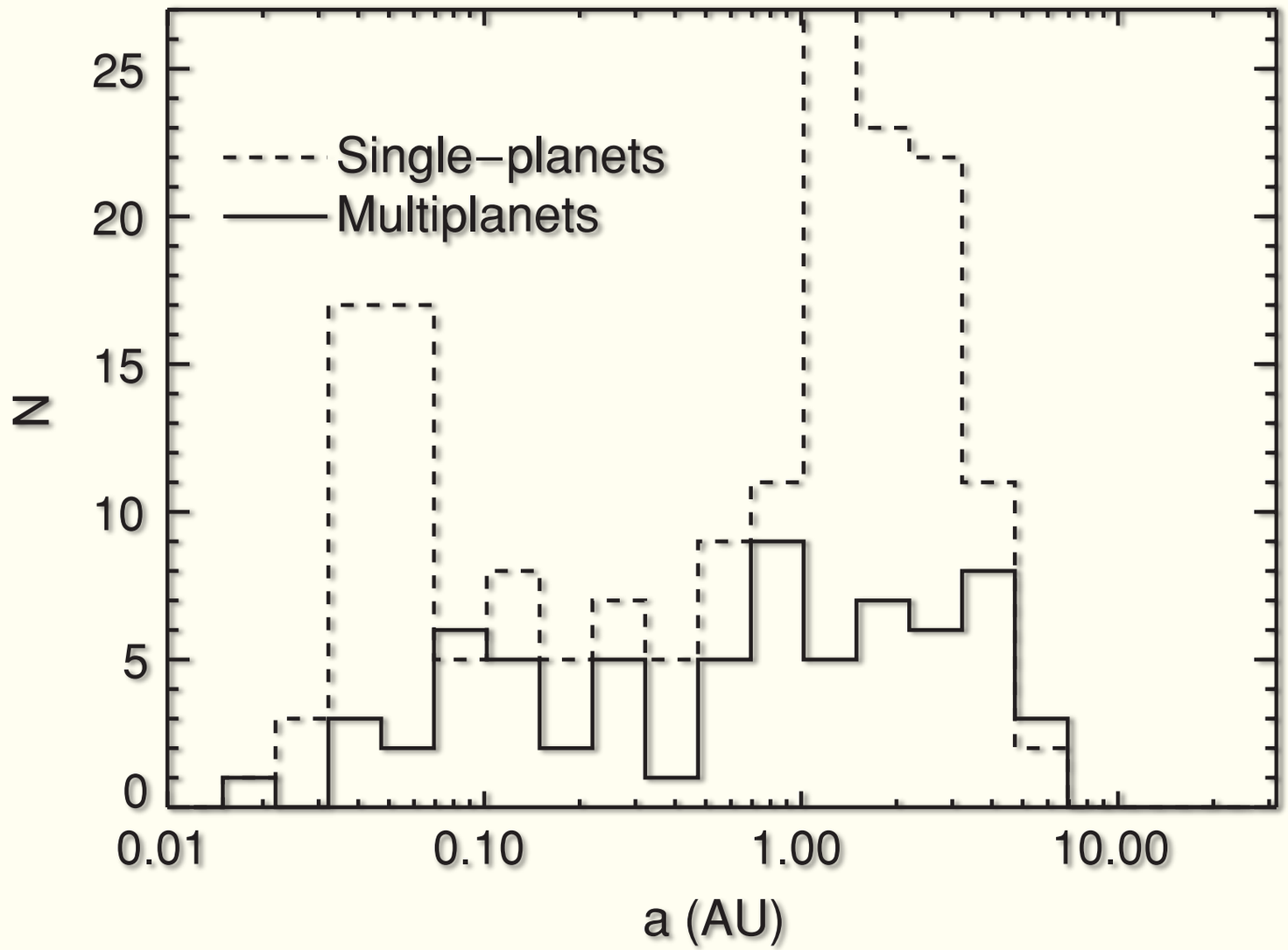
Planet scattering + Kozai + tidal friction
Should have a population of far away Jupiters (Fomalhaut b?)

SCATTERING + TIDAL	NAGASAWA ET AL. 2008



Most systems are born in Open Clusters
Highly dense, singletons, can become binaries and singletons again.

OUTSIDE INFLUENCE | MALMBERG ET AL. 2007



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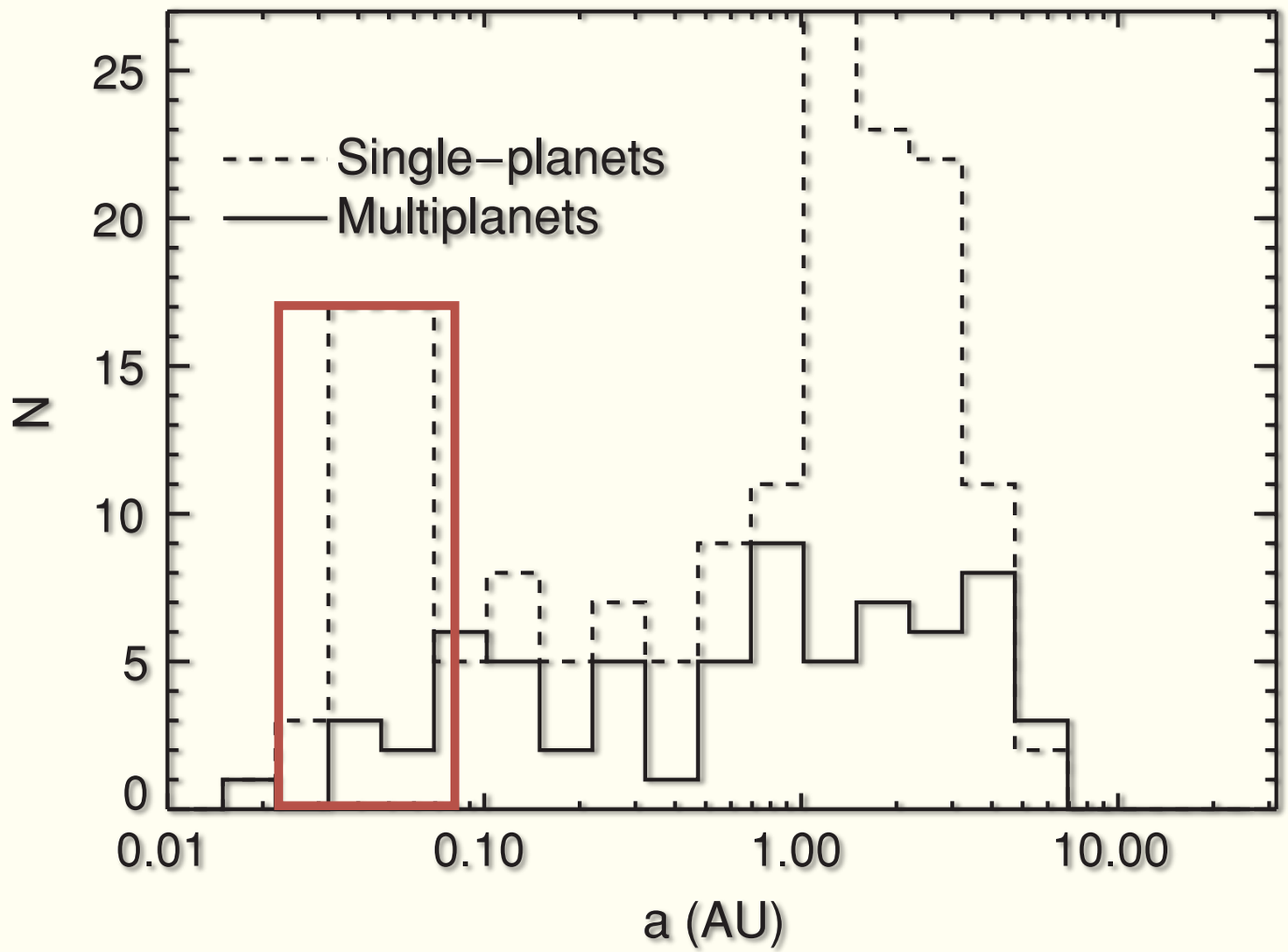

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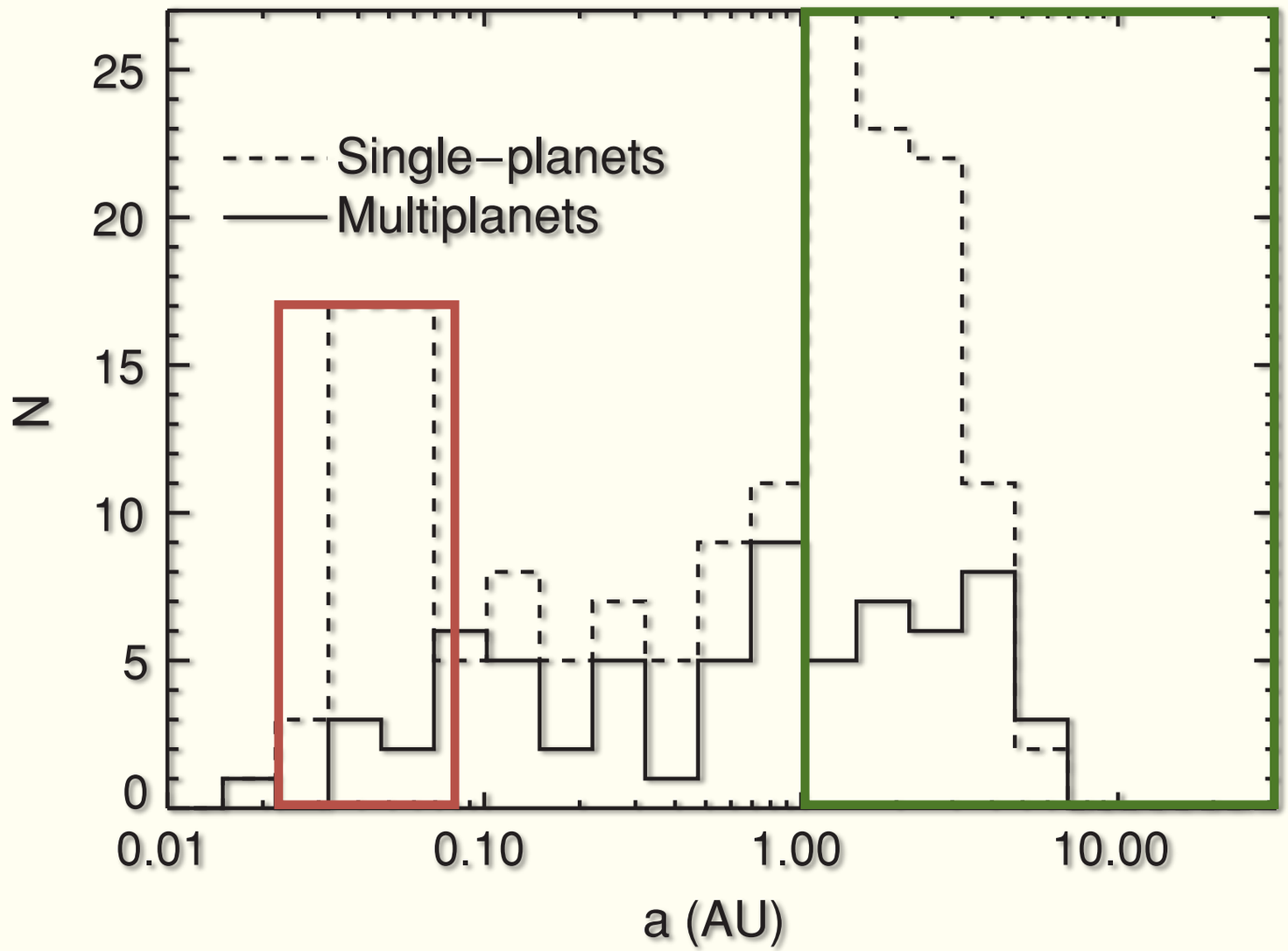

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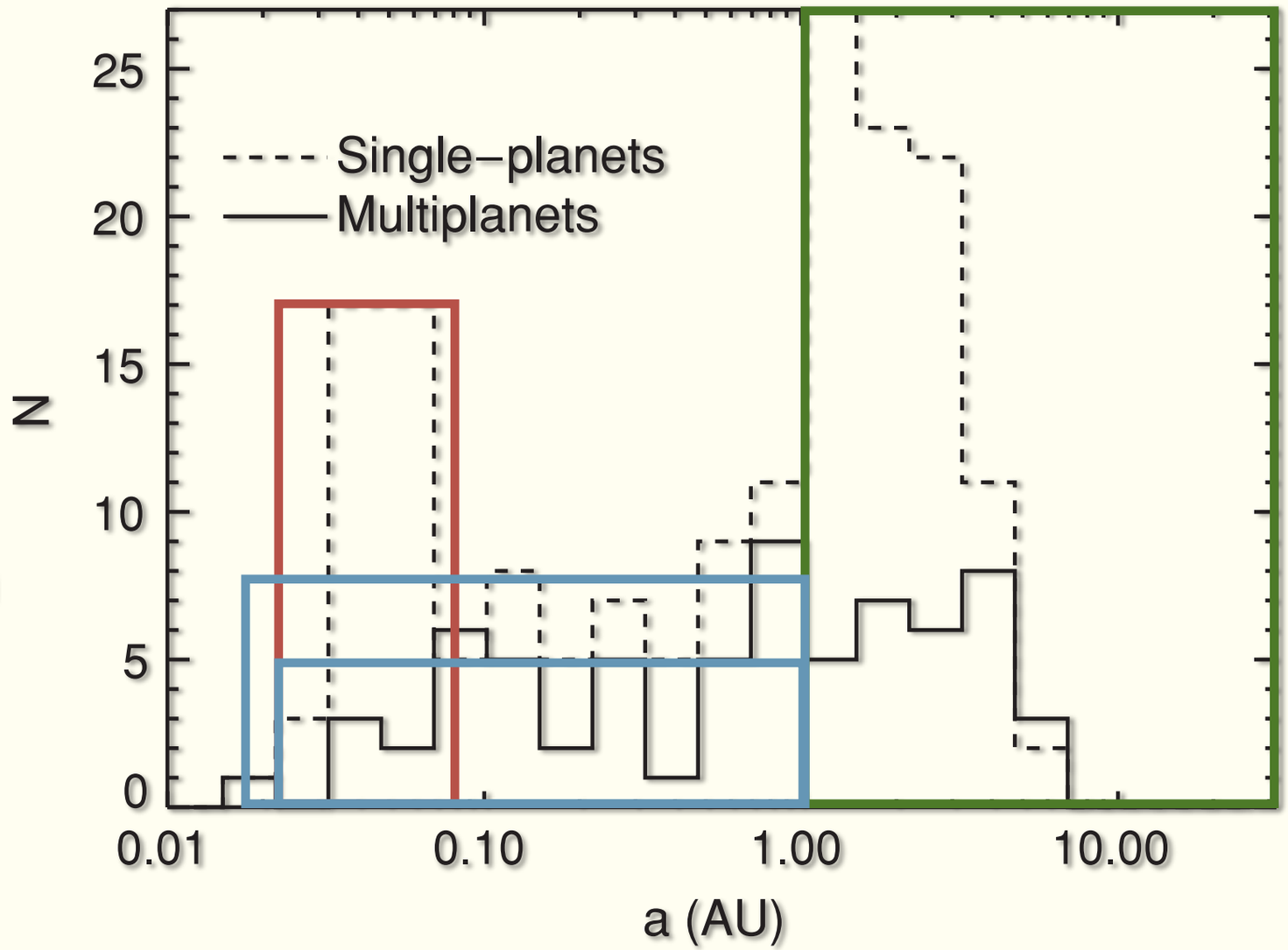

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