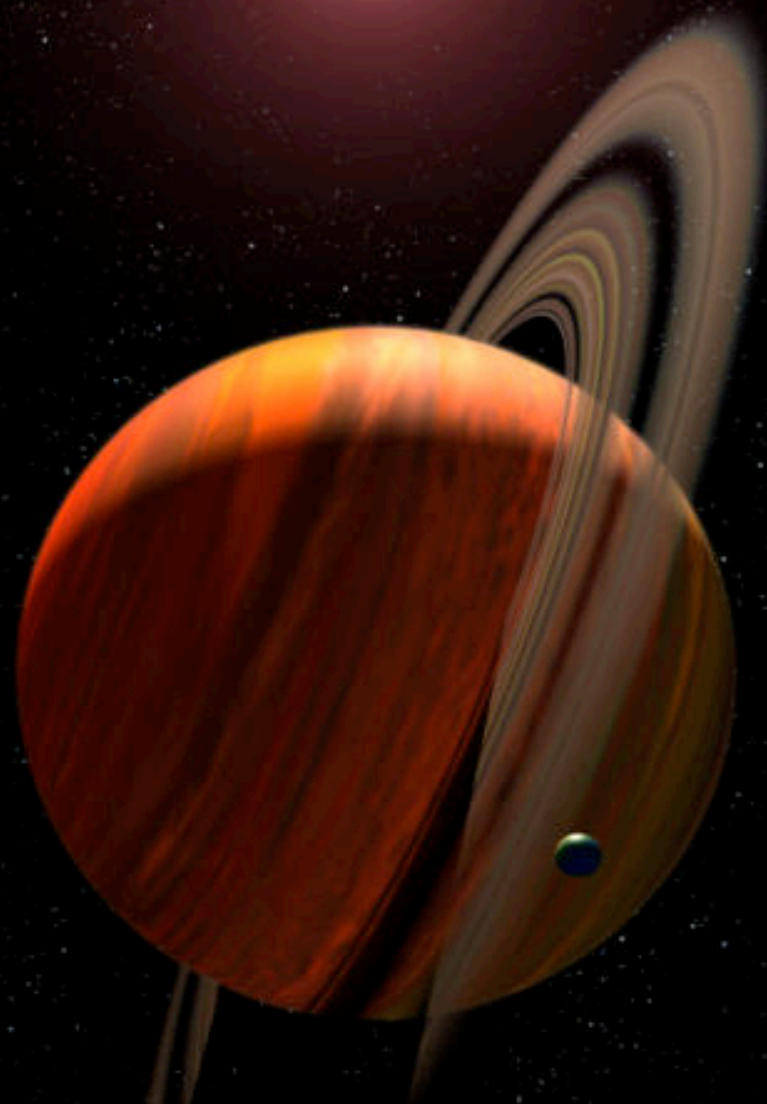


Exoplanet Properties, System Architectures and Host Stars

John Asher Johnson

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What we knew in 1994

- Planets form in disks
 - Planets orbit in same direction as stellar spin, and in same direction as other planets.
- Giant planets have circular orbits
- Giant planets reside near where they formed, beyond the “iceline”
- Giant planets have a $\sim 10 M_{\text{Earth}}$ core surrounded by a gaseous envelope

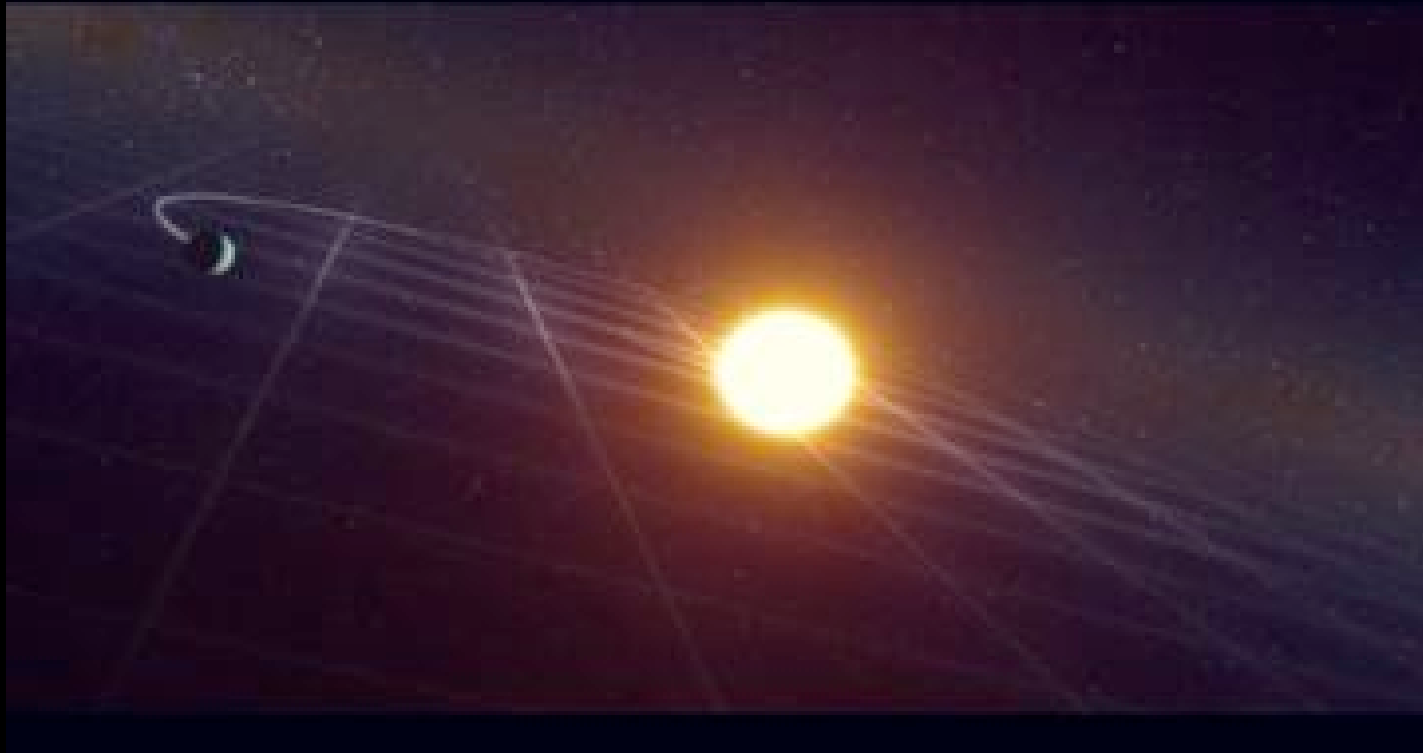
What We Expected



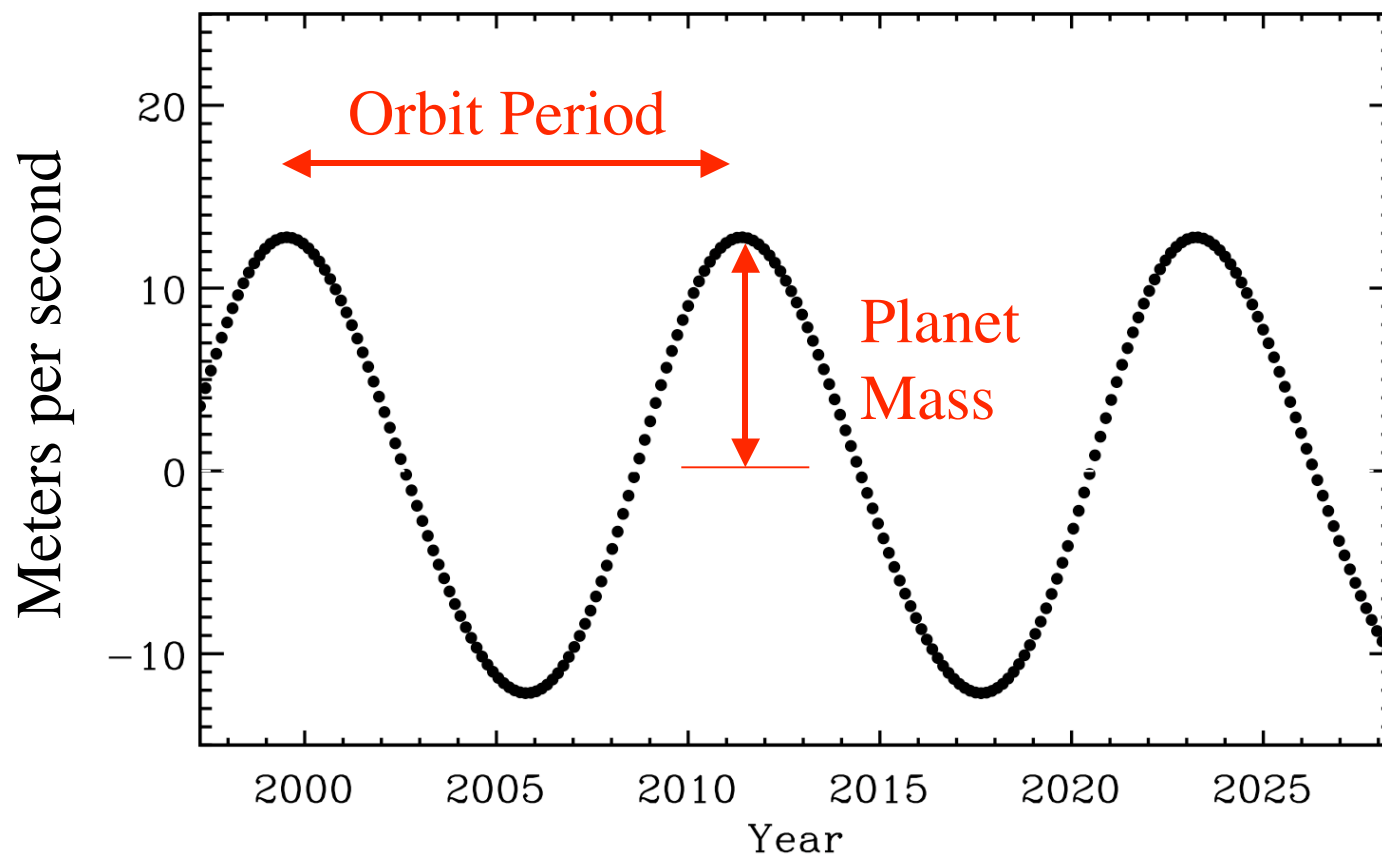
Rocky planets
in close

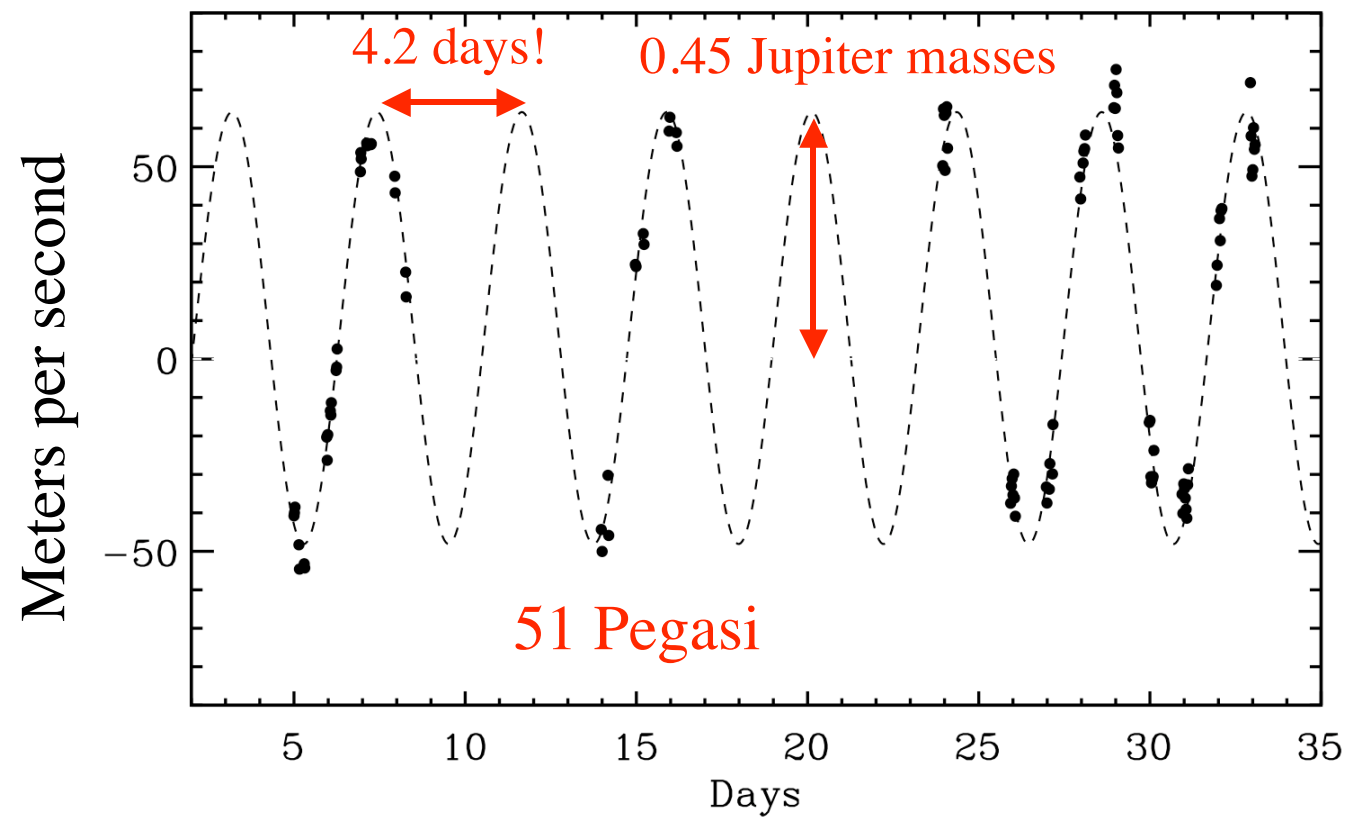
Gas giants far away

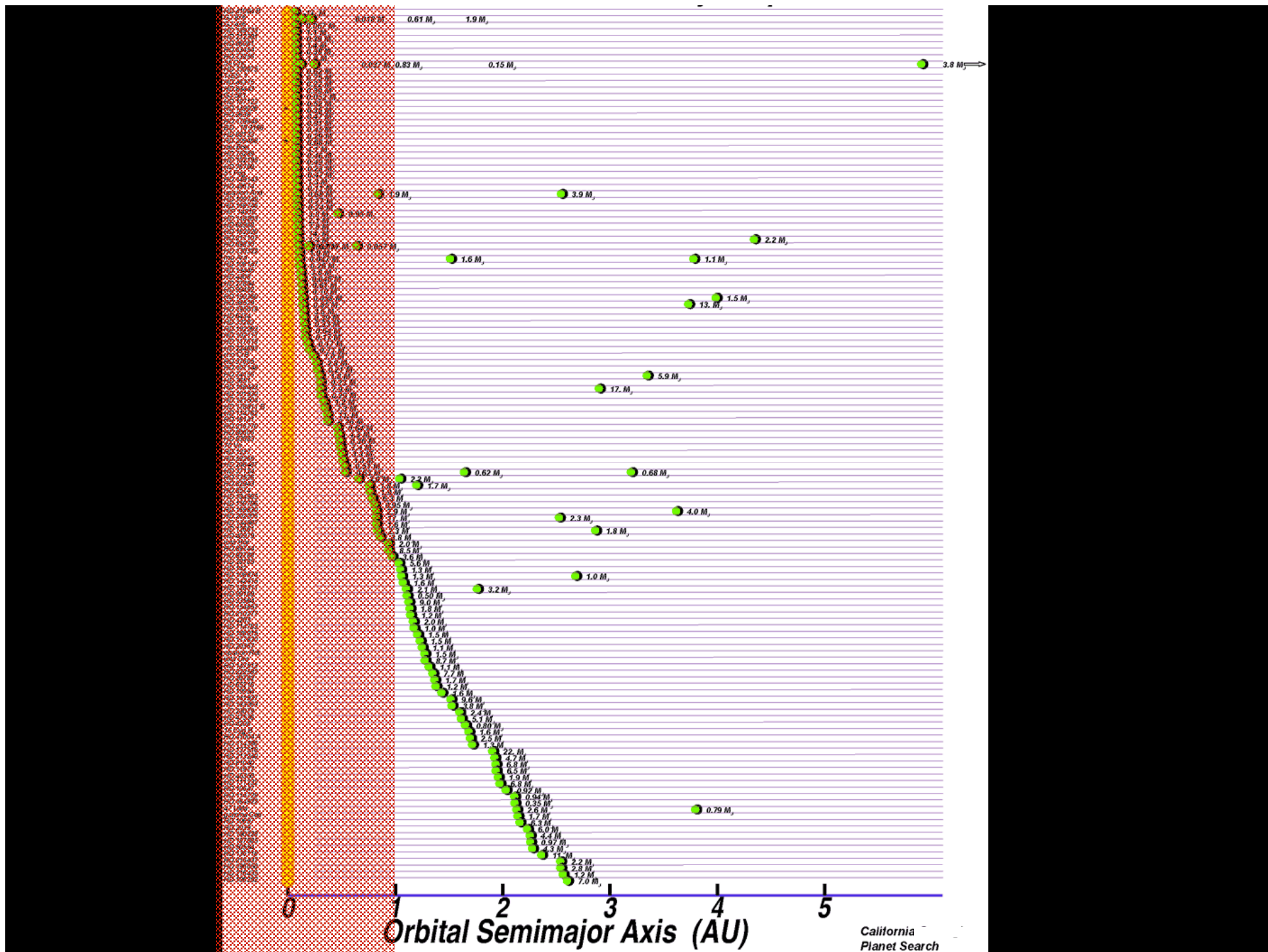
High-Precision Radial Velocities

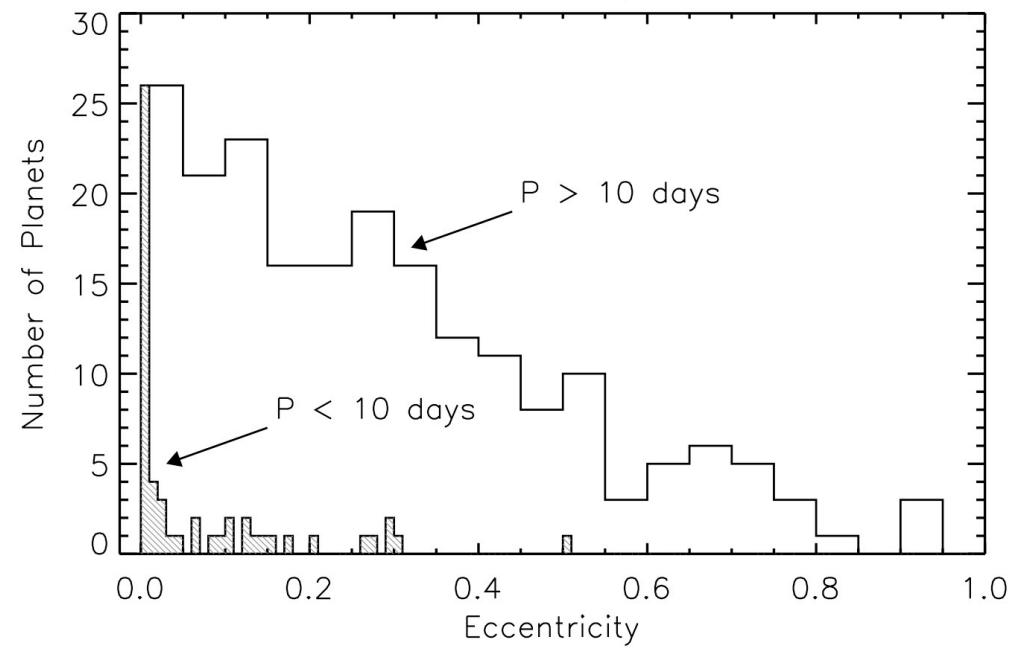
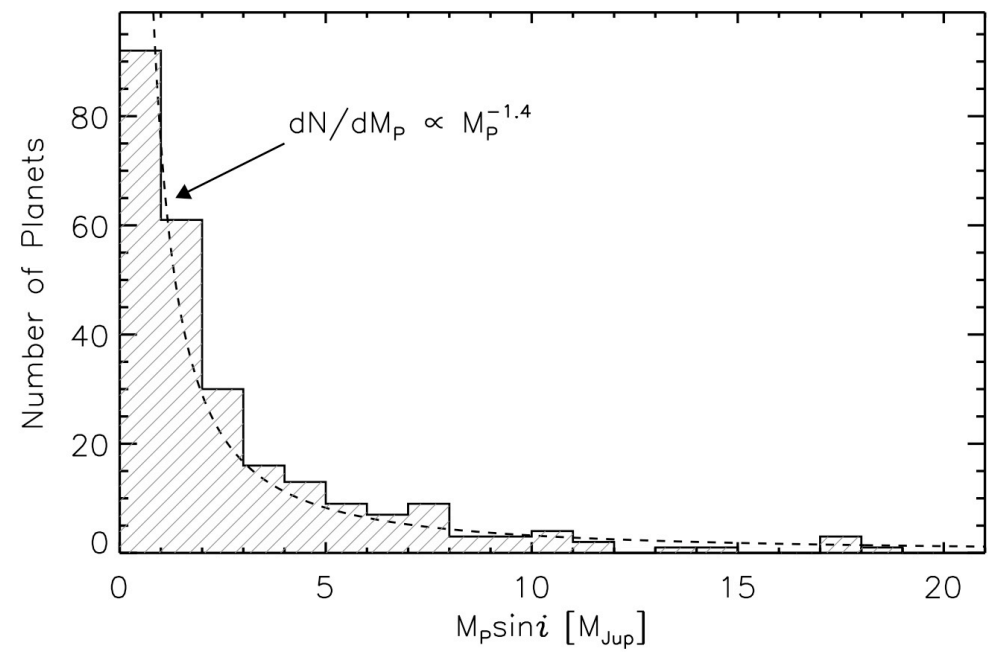


95% of known exoplanets have been
discovered or confirmed by Doppler measurements

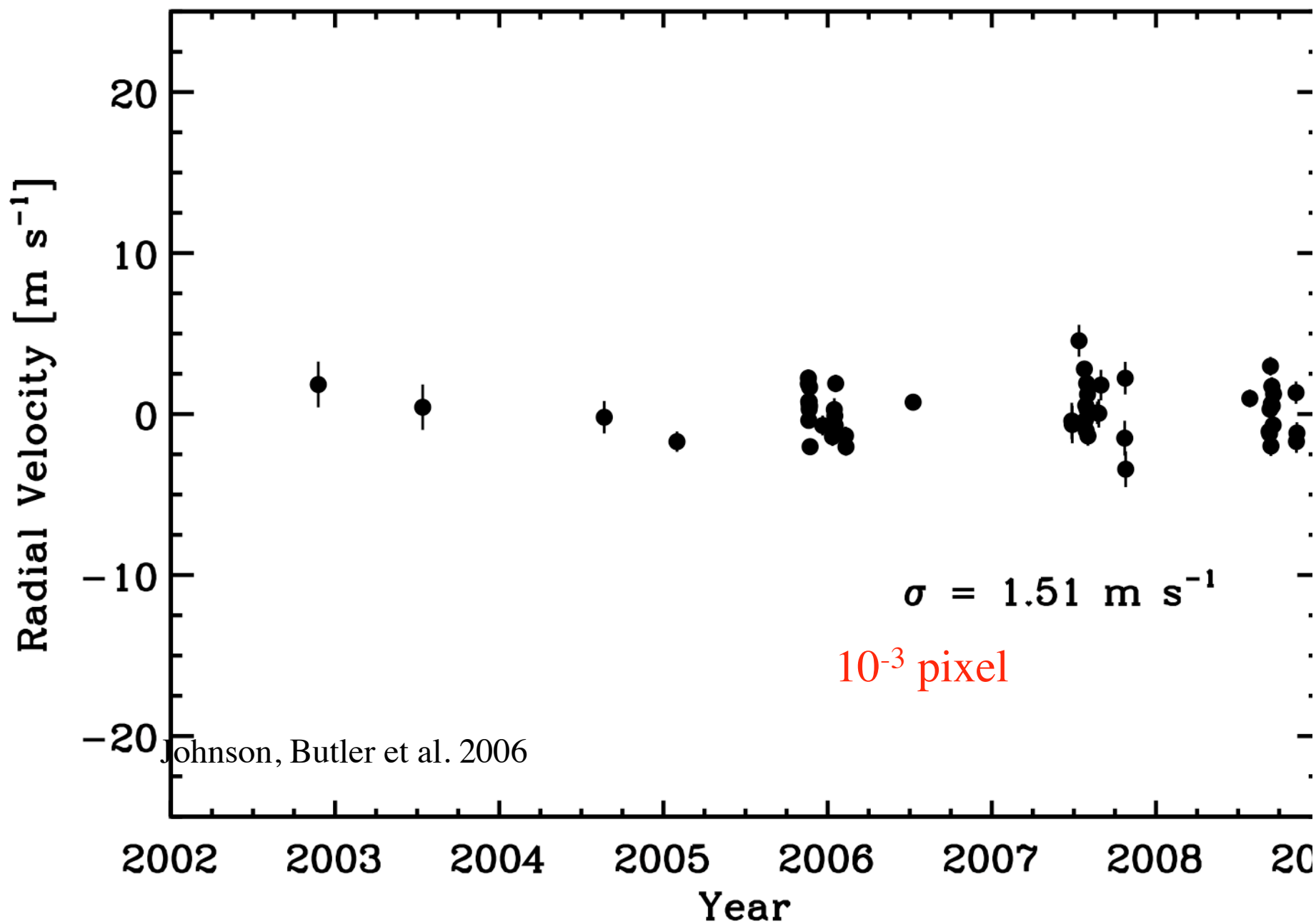


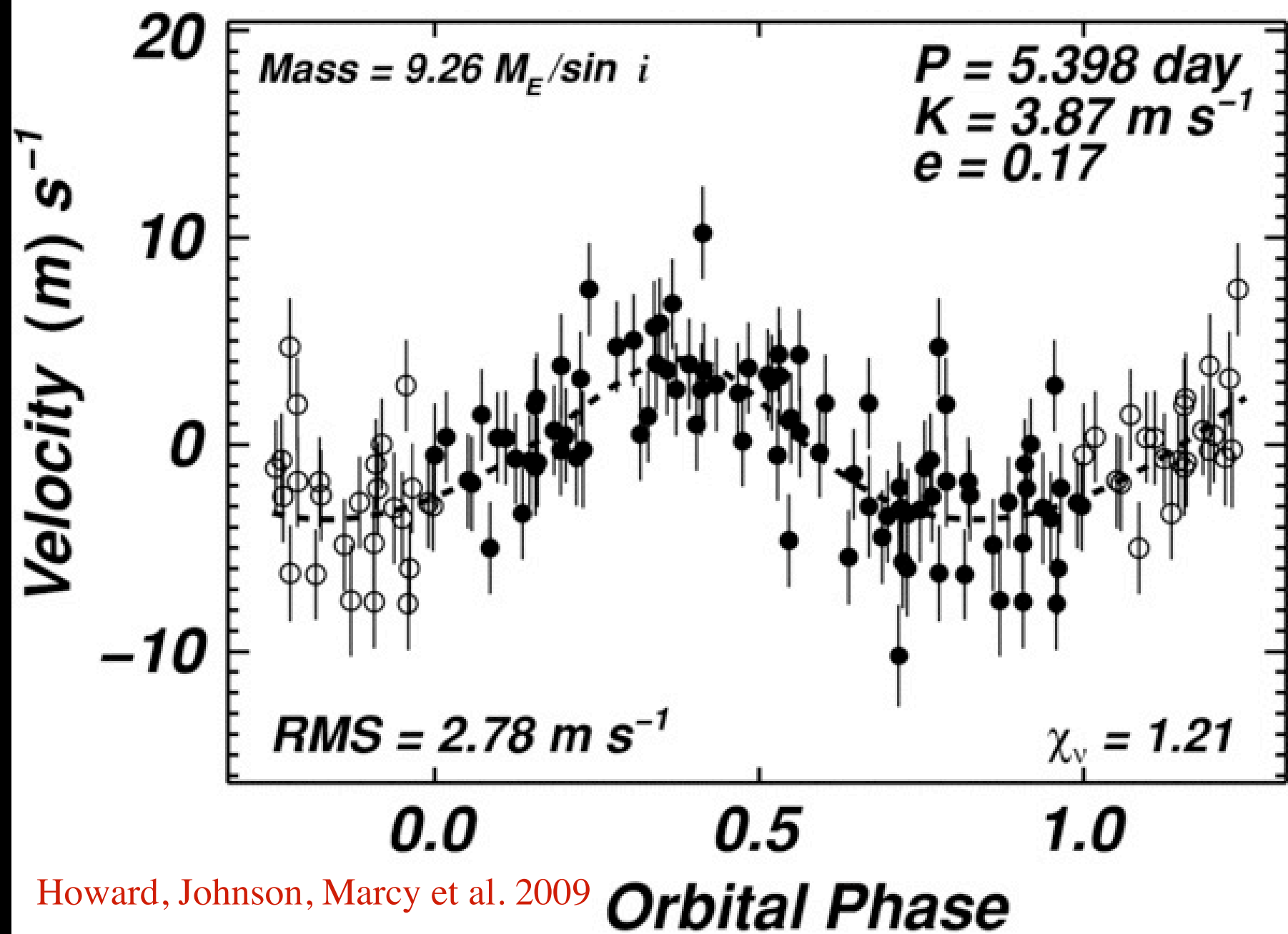






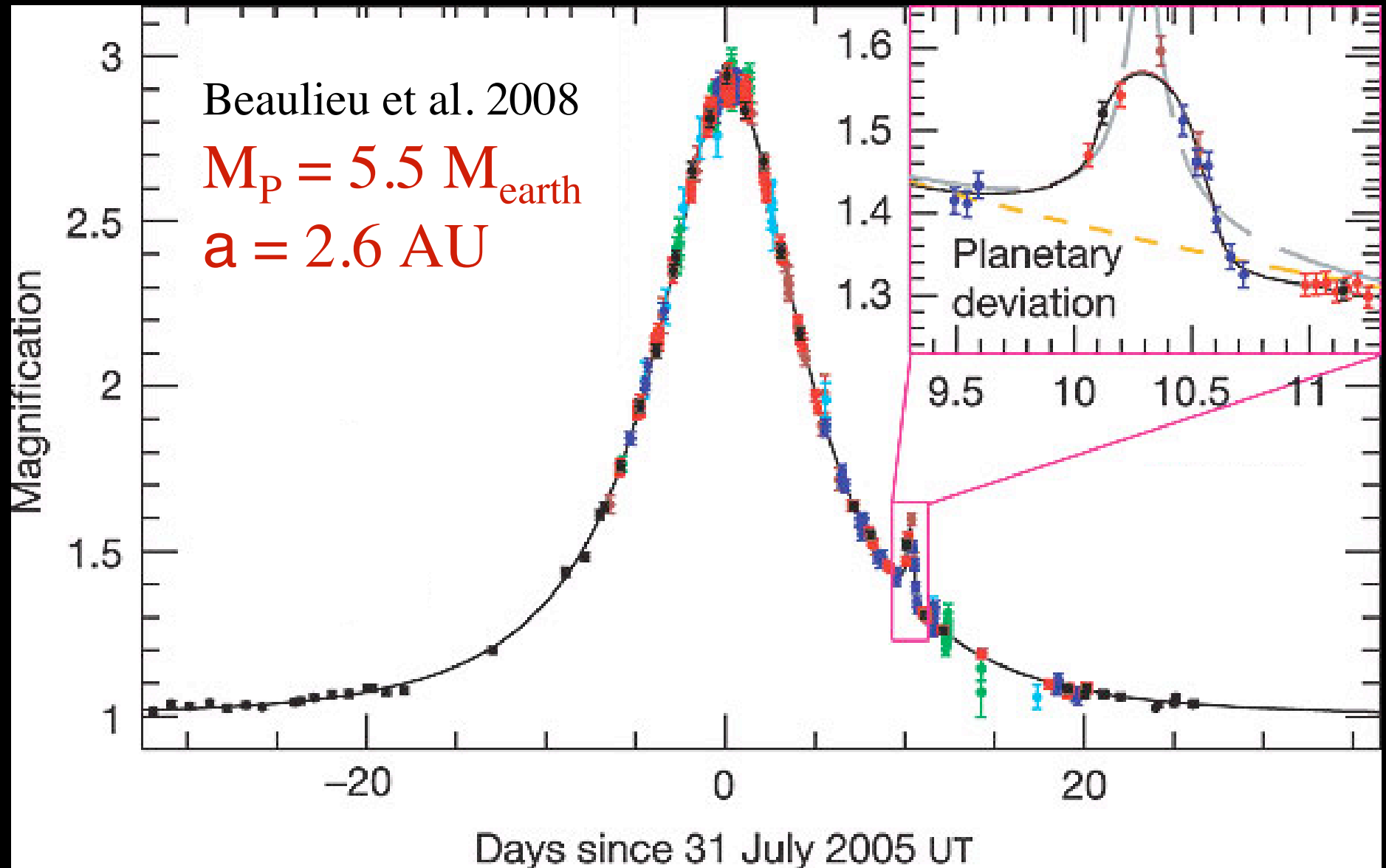
HD 9407

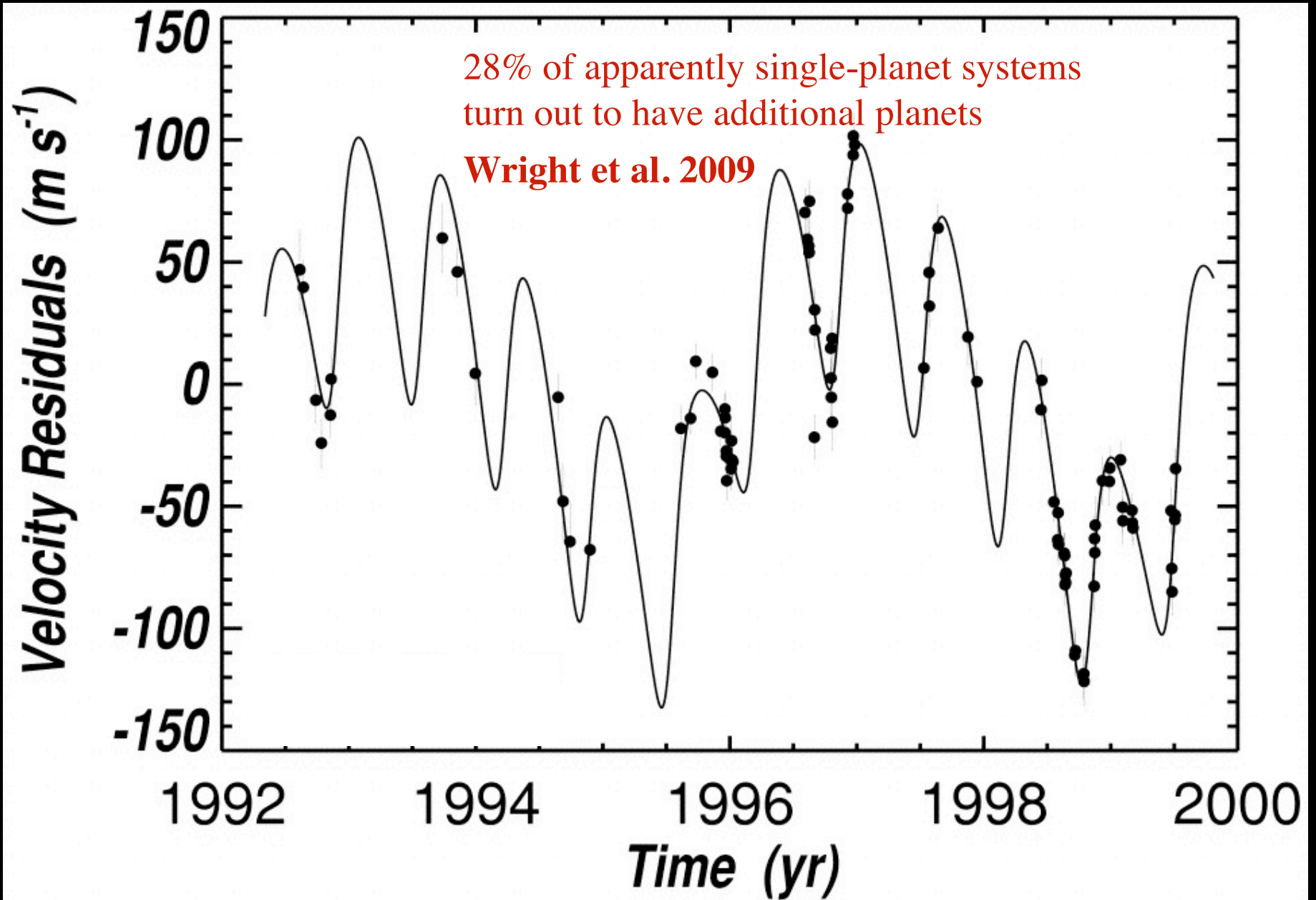




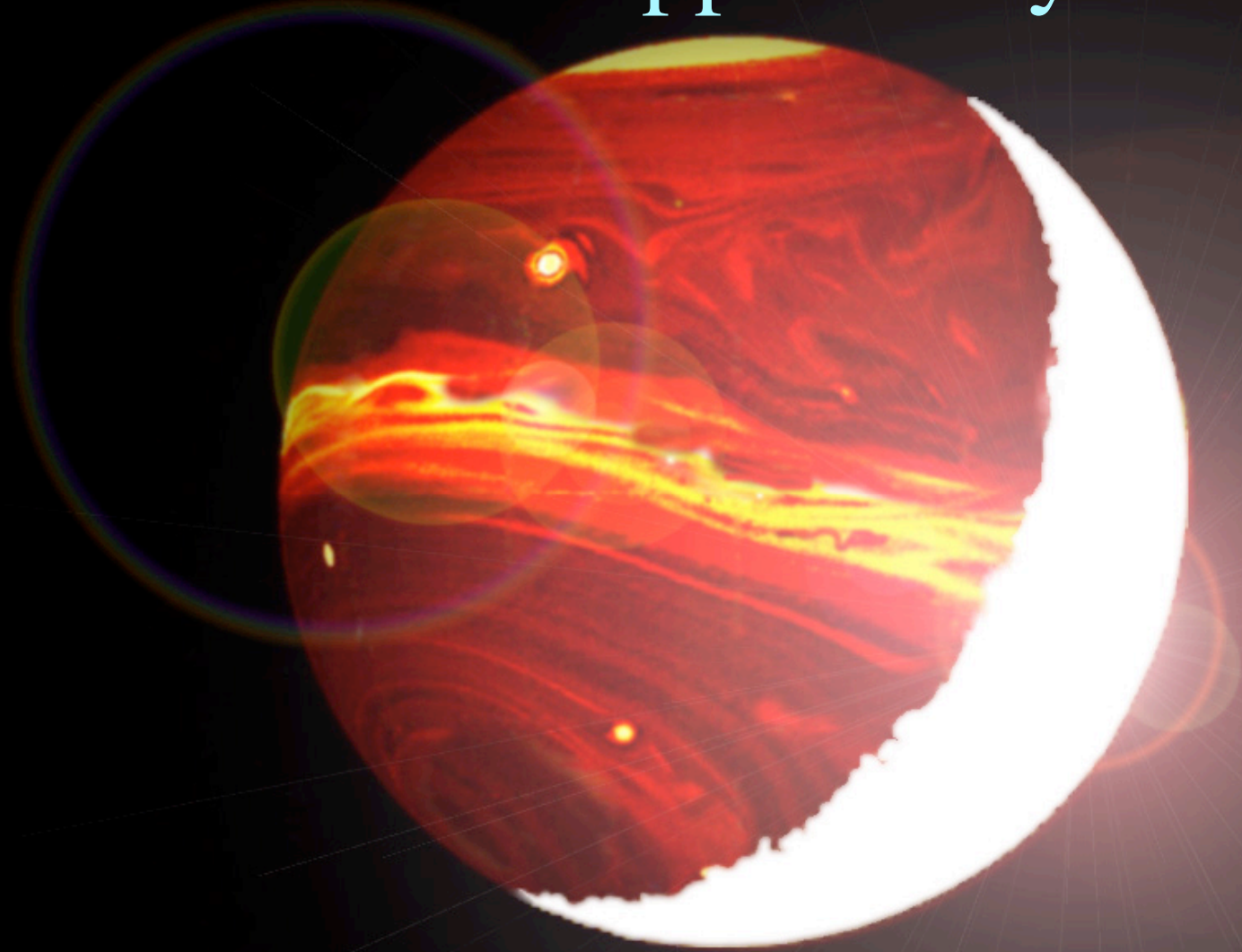
Howard, Johnson, Marcy et al. 2009

OGLE-2005-BLG-390b





Hot Jupiters: A Problem and an Opportunity



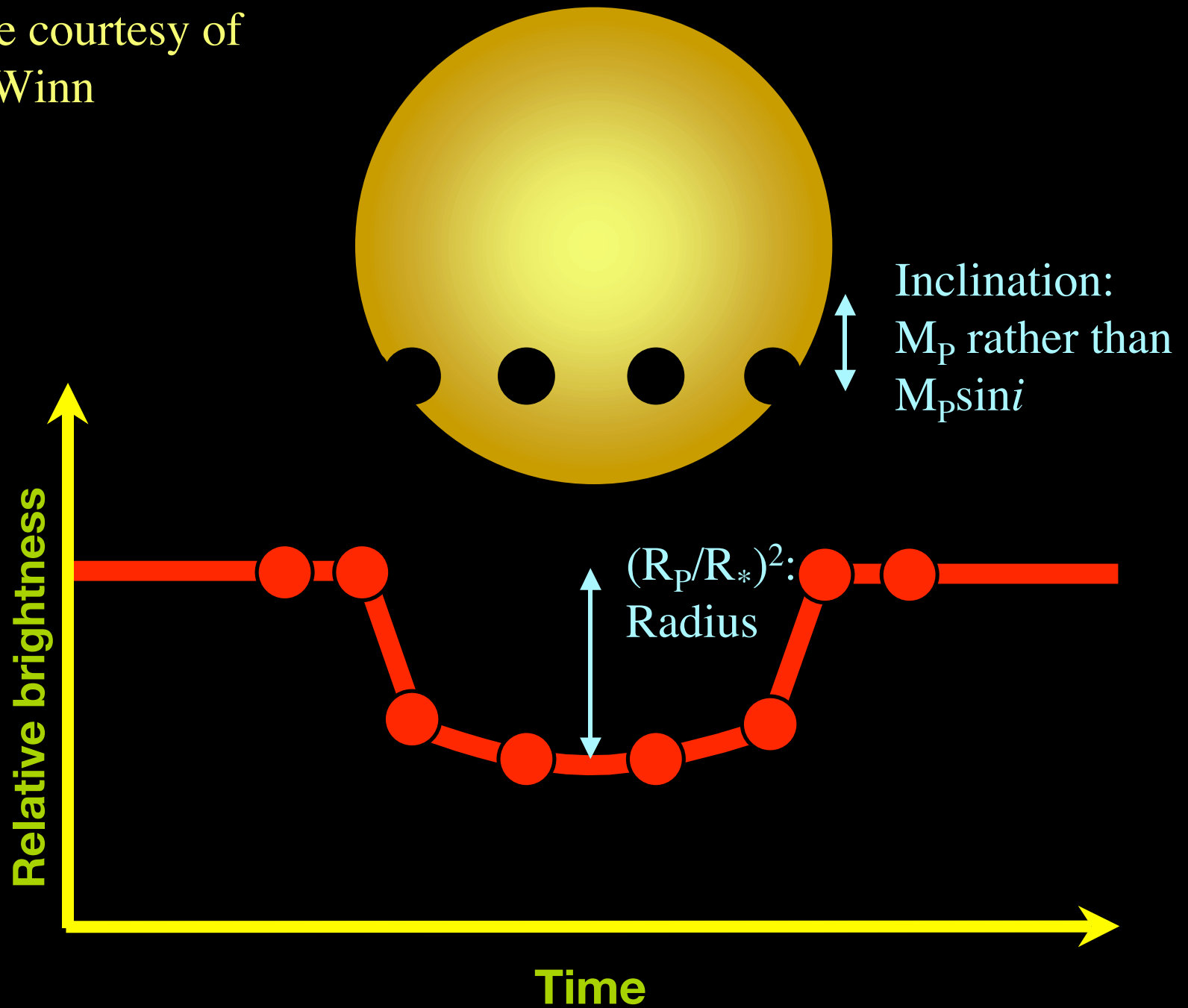
The Problem of Forming Hot Jupiters



The “Ice Line”

in situ formation unlikely

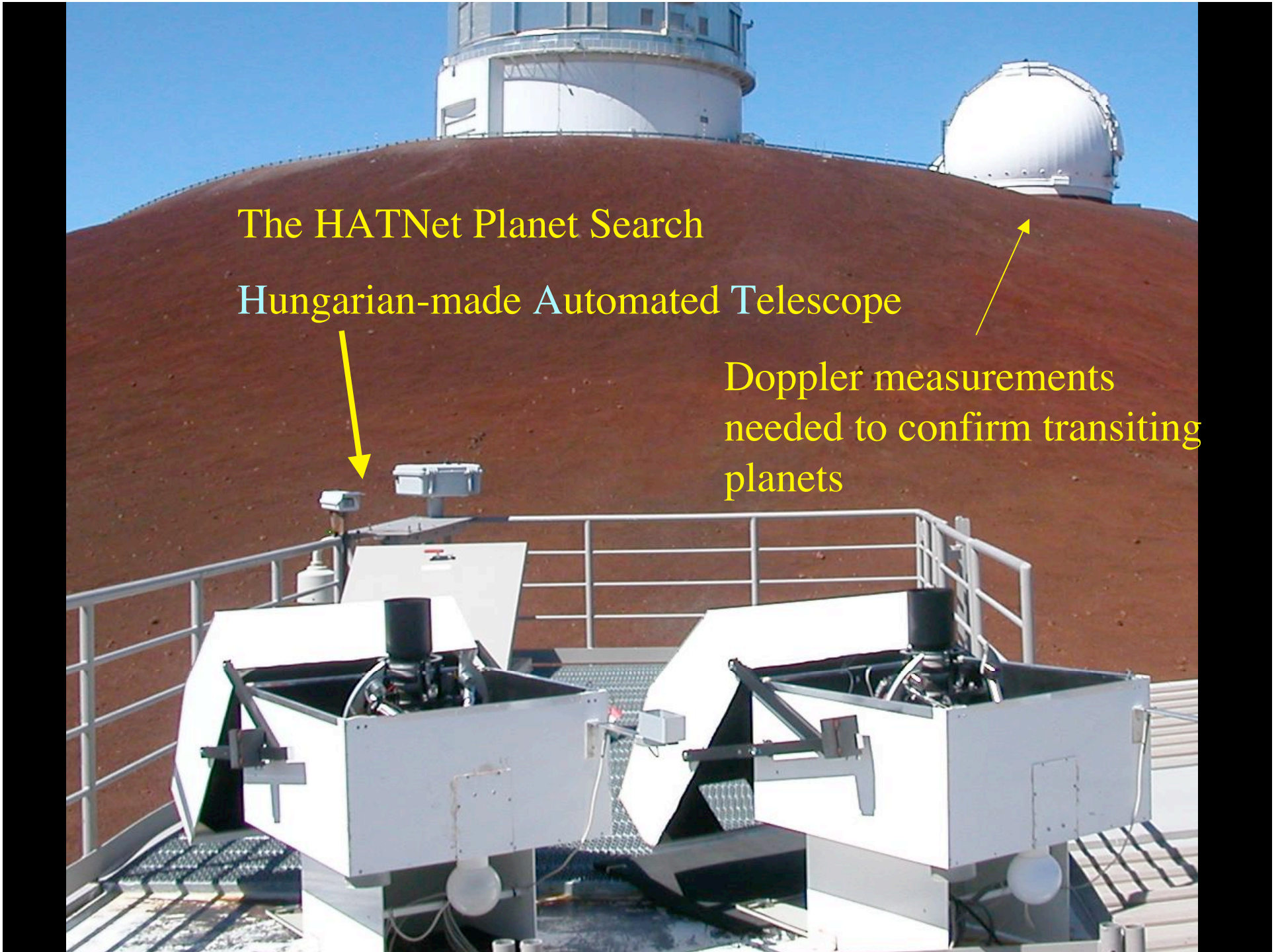
Figure courtesy of
Josh Winn



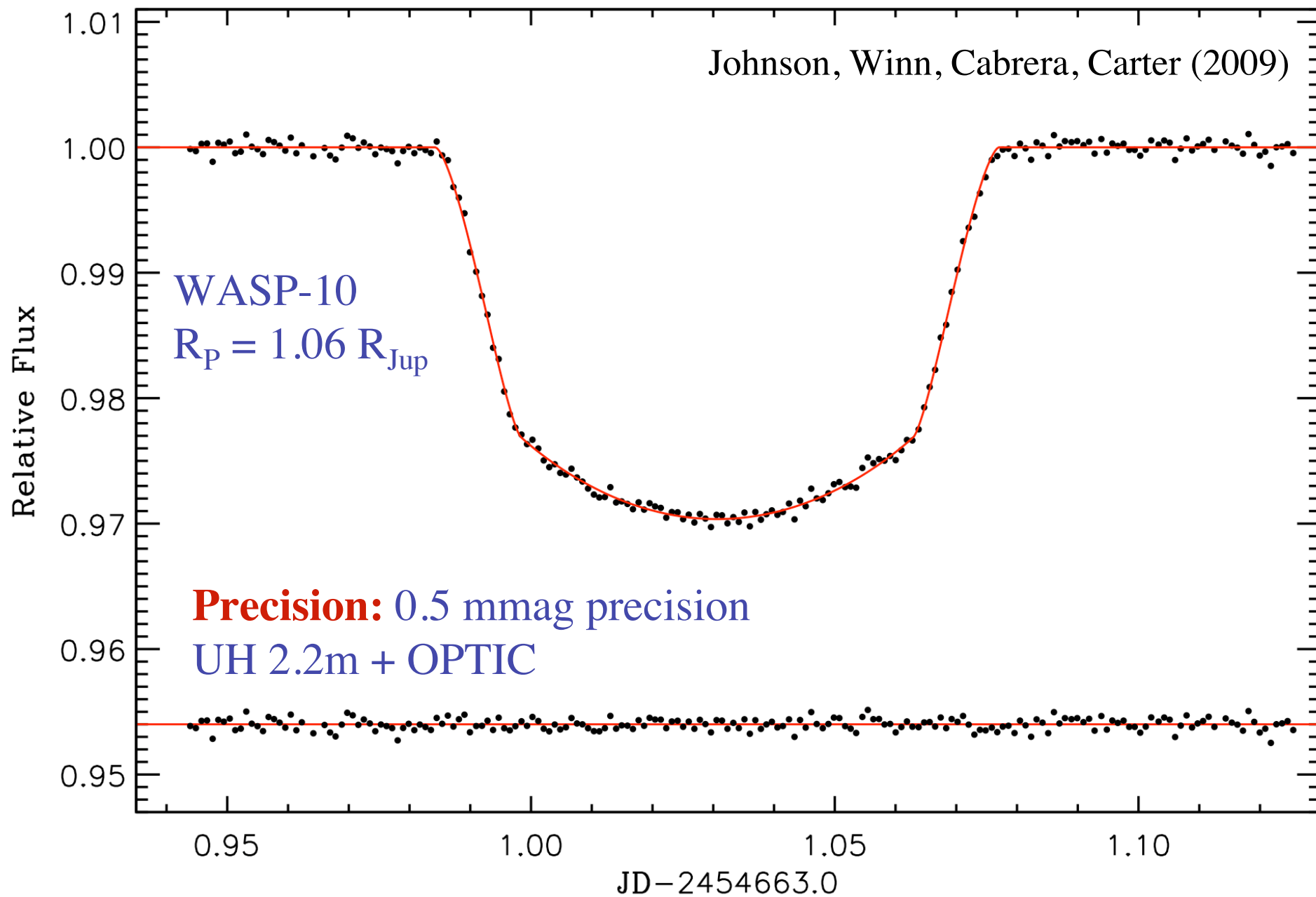
The HATNet Planet Search

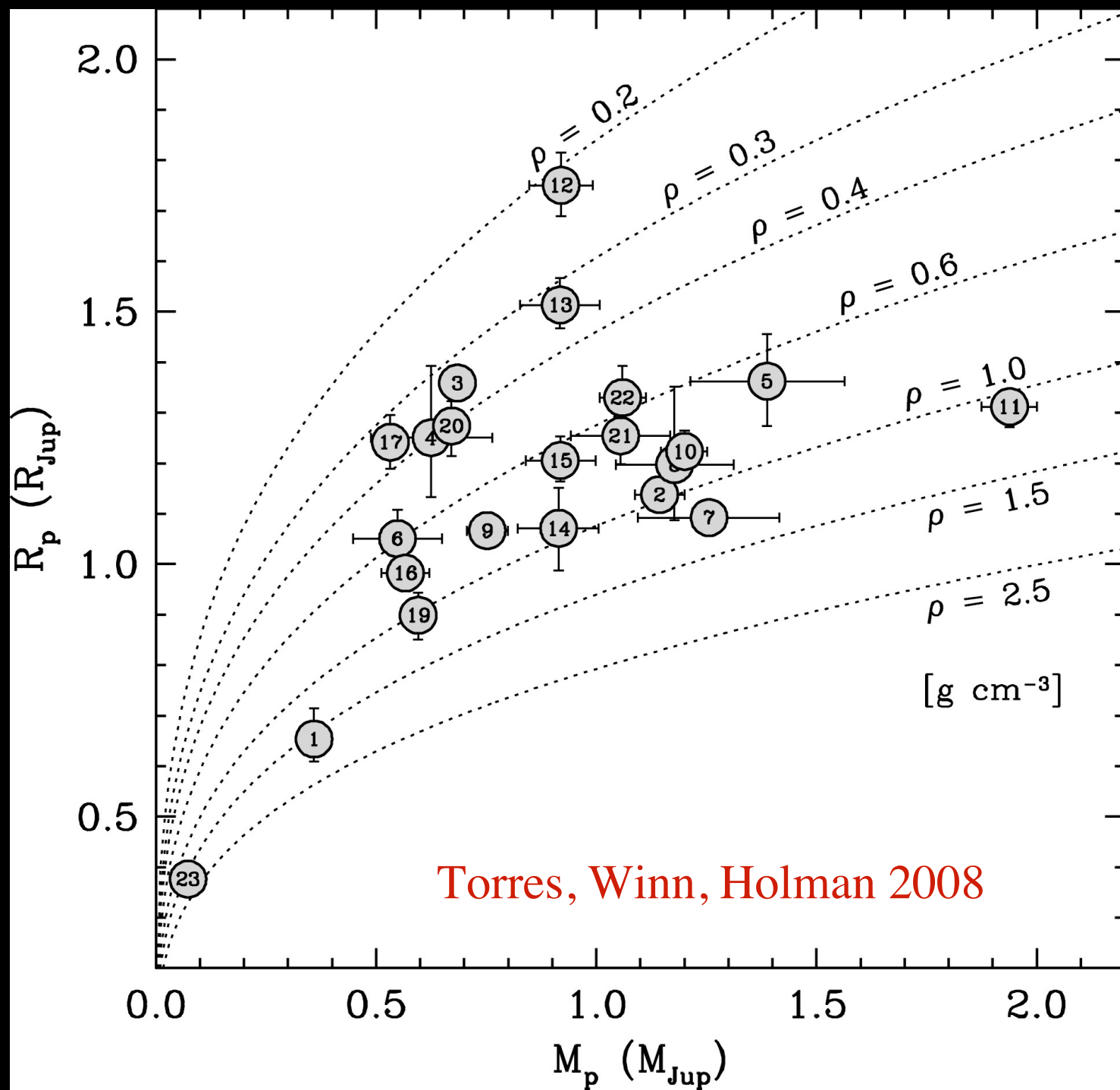
Hungarian-made Automated Telescope

Doppler measurements
needed to confirm transiting
planets

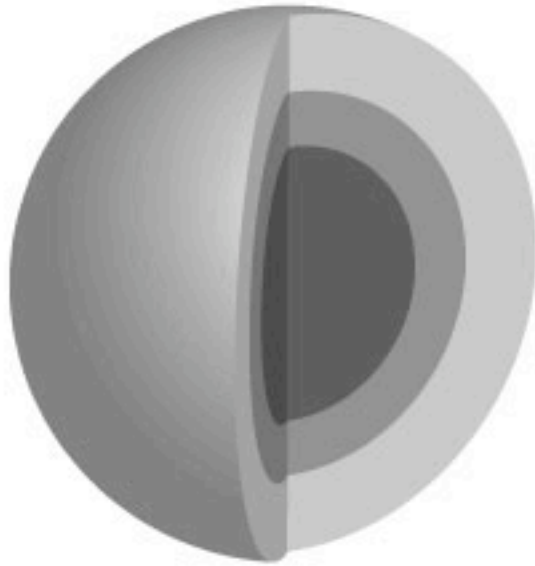


Johnson, Winn, Cabrera, Carter (2009)

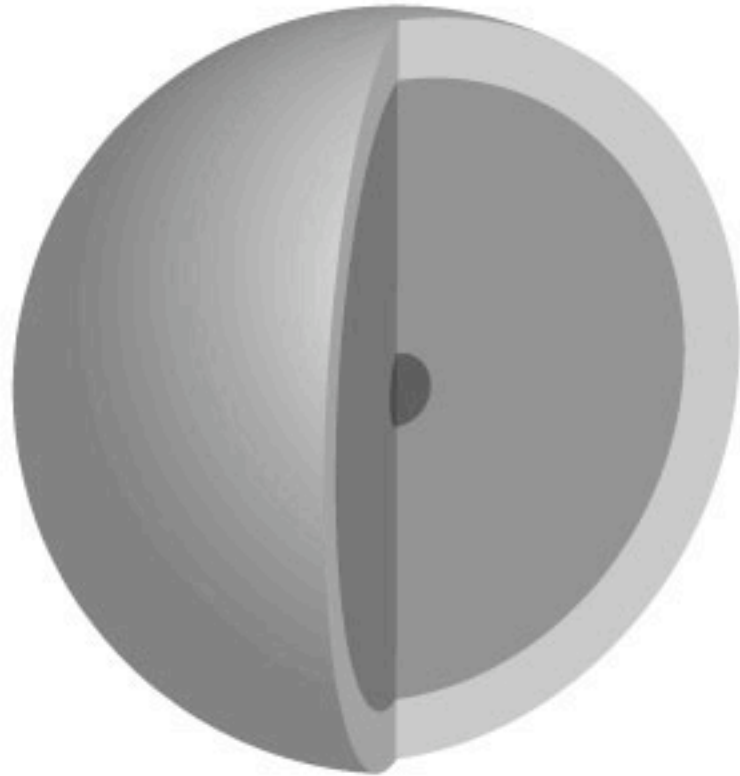







Torres, Winn, Holman 2008

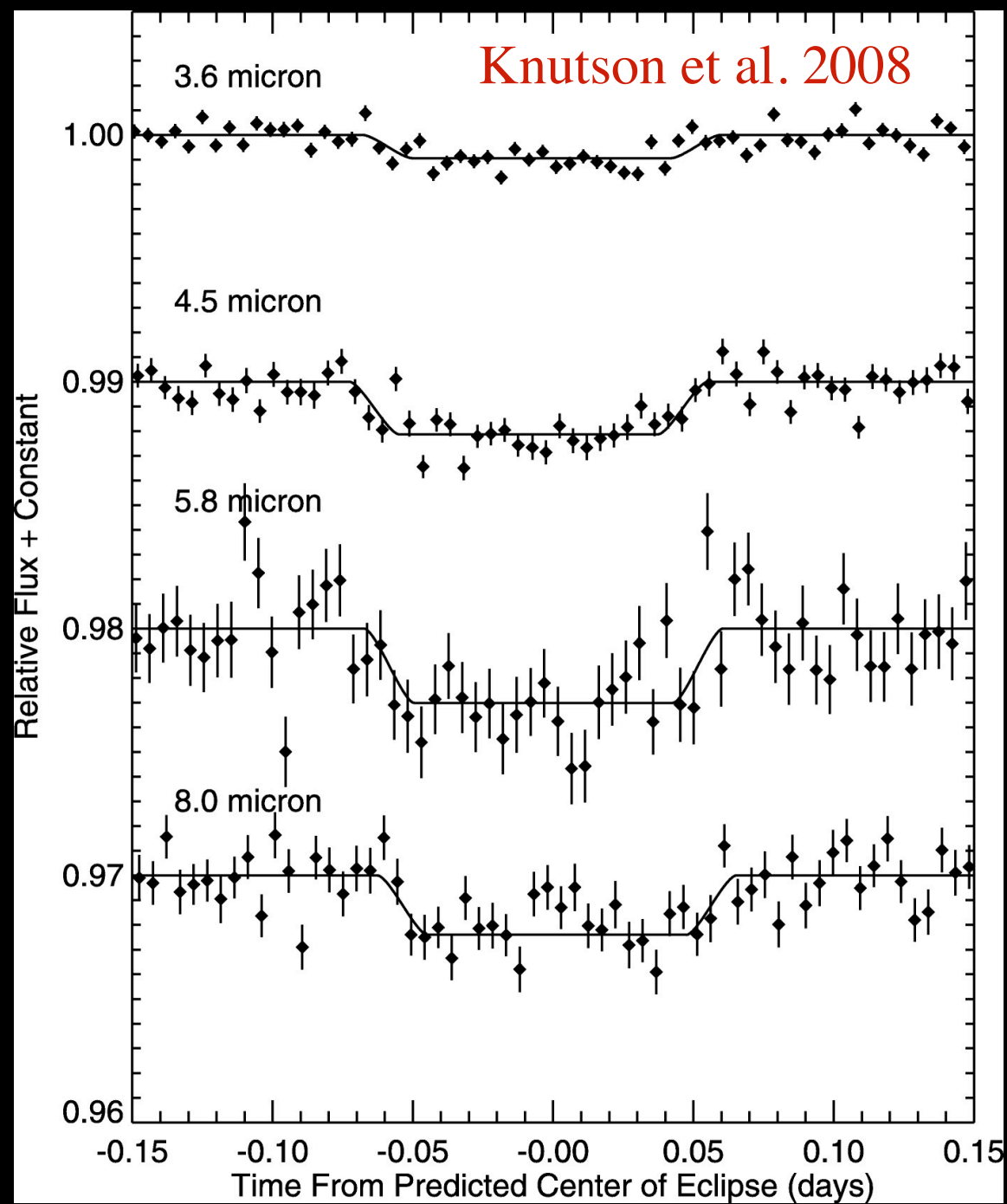


HD 149026 b

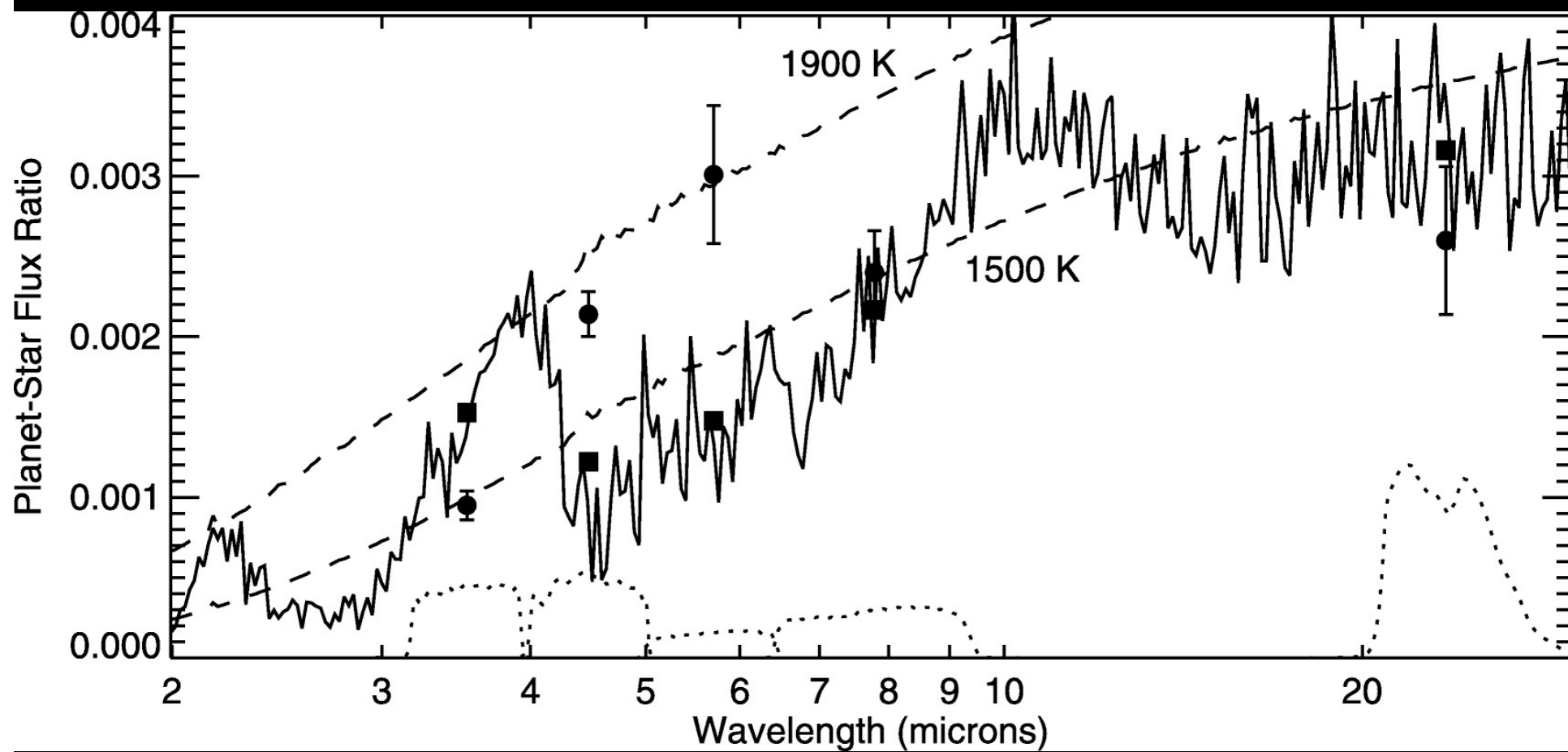


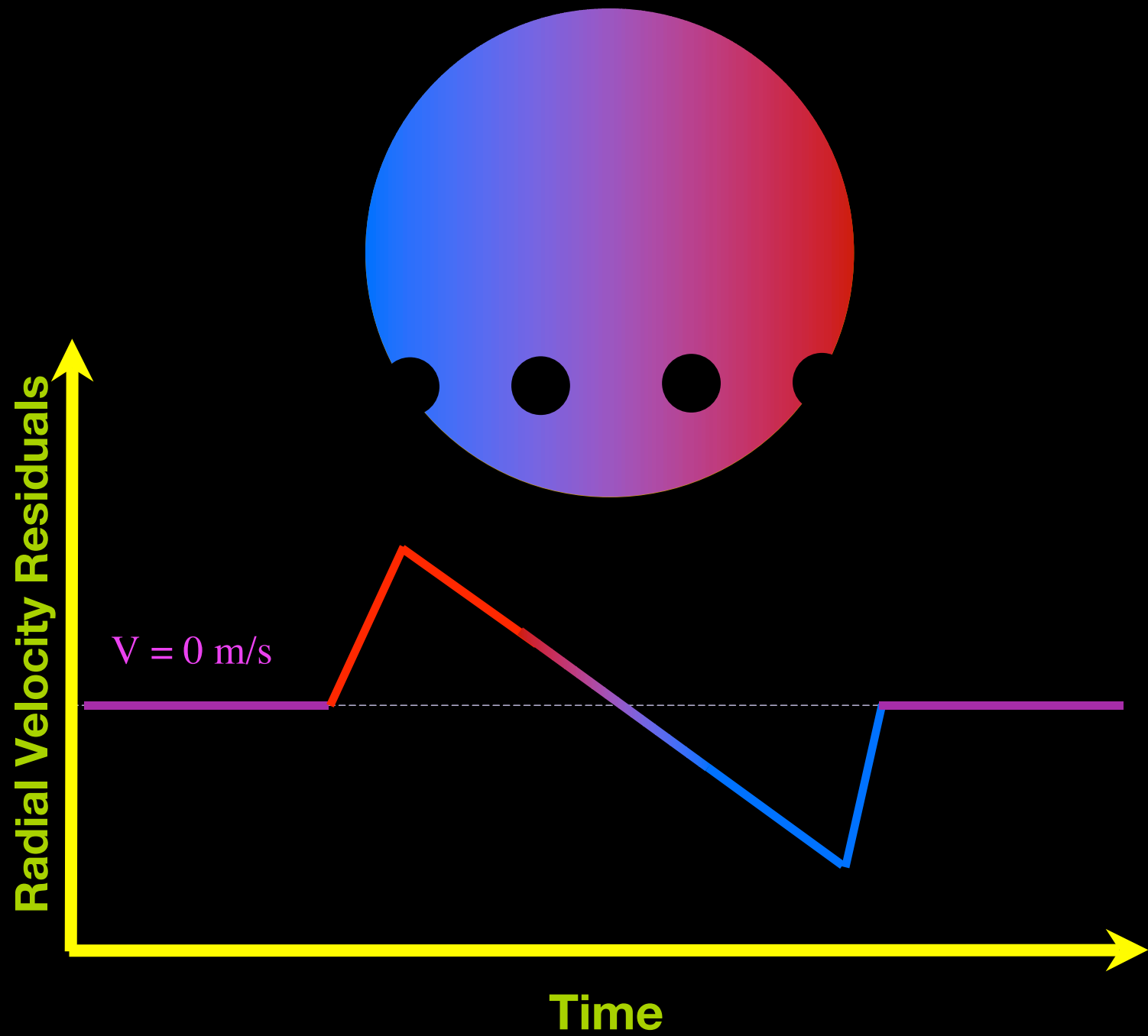
Jupiter

-  hydrogen and helium gas
-  liquid metallic hydrogen
-  heavy element core



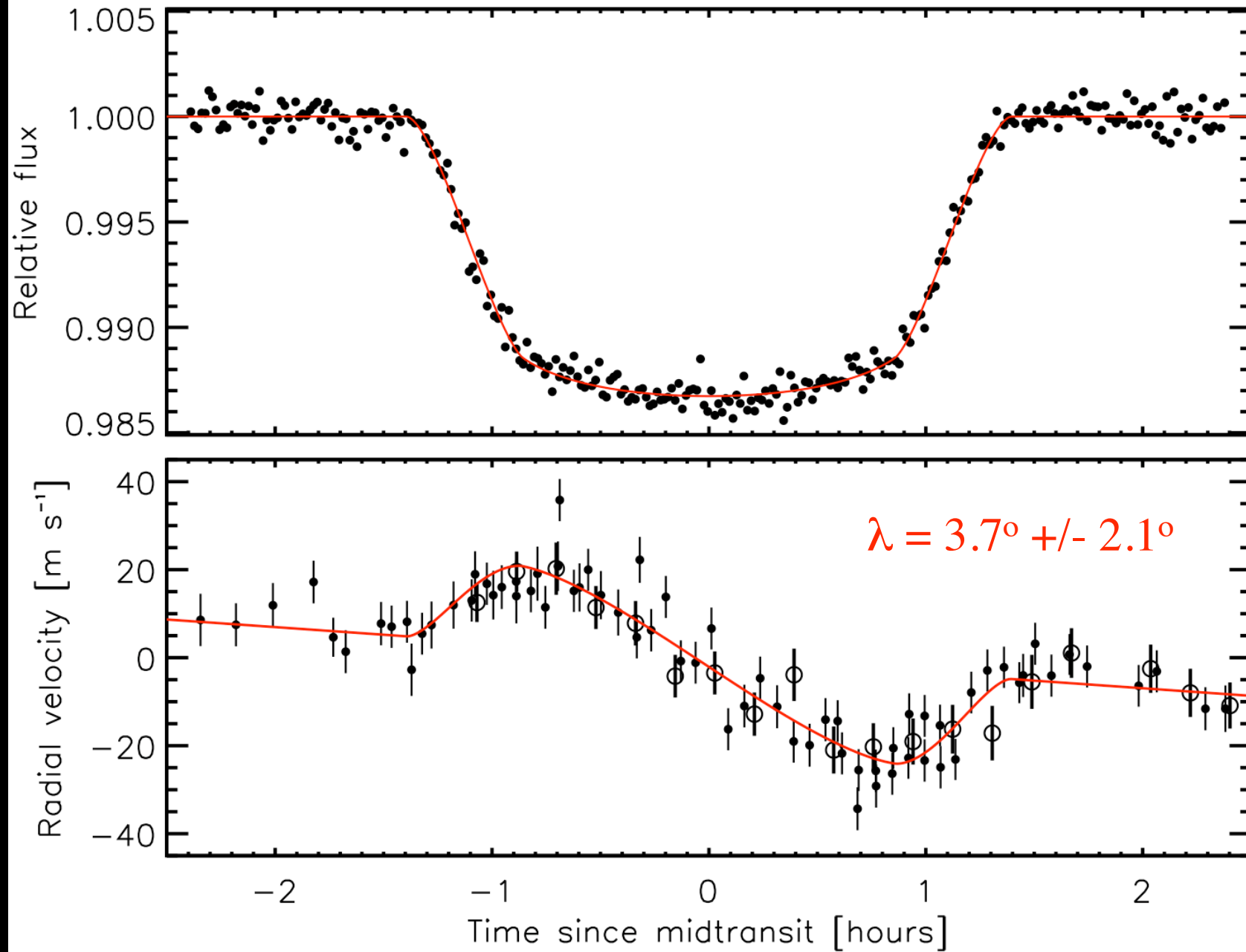
Knutson et al. 2008

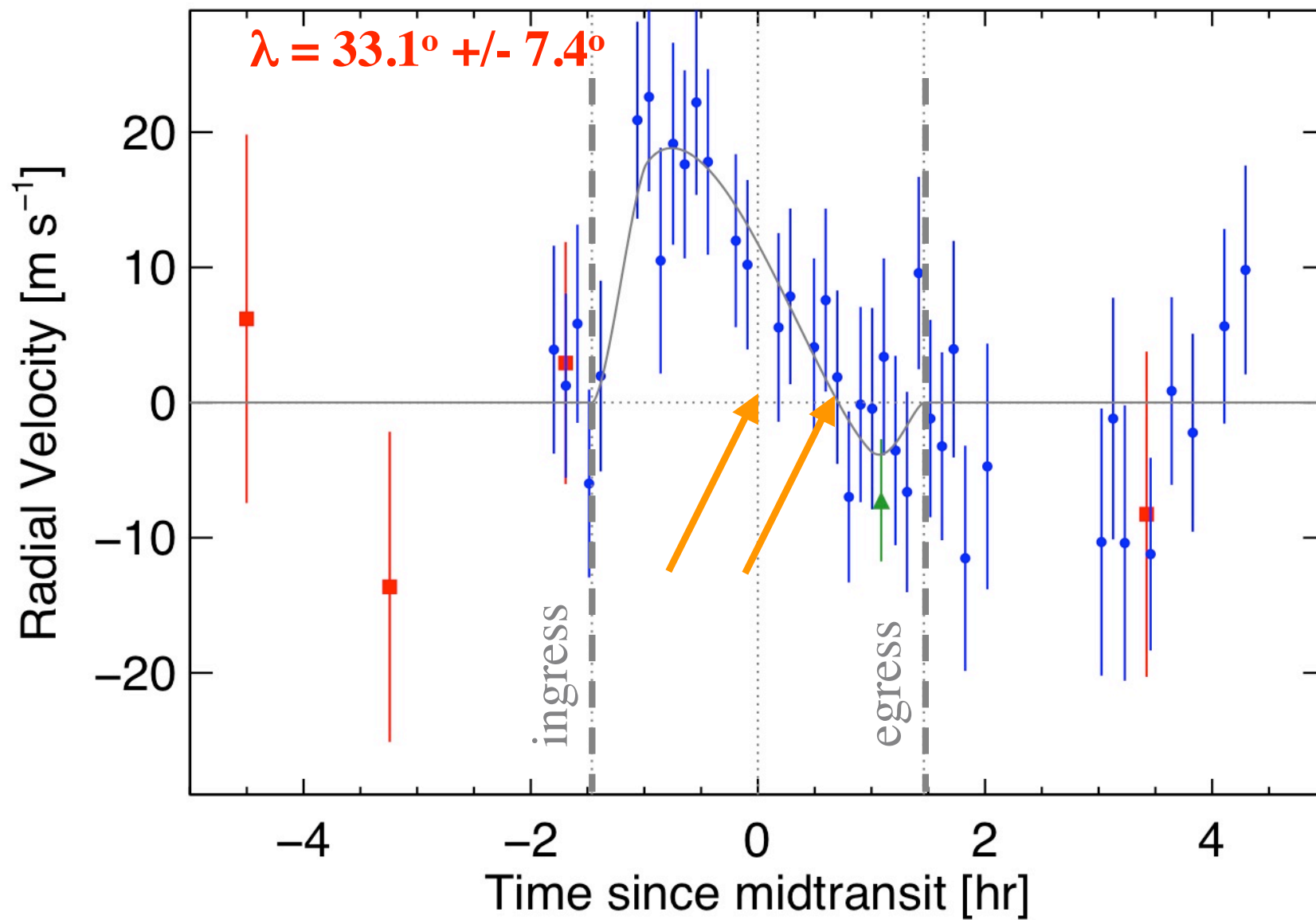




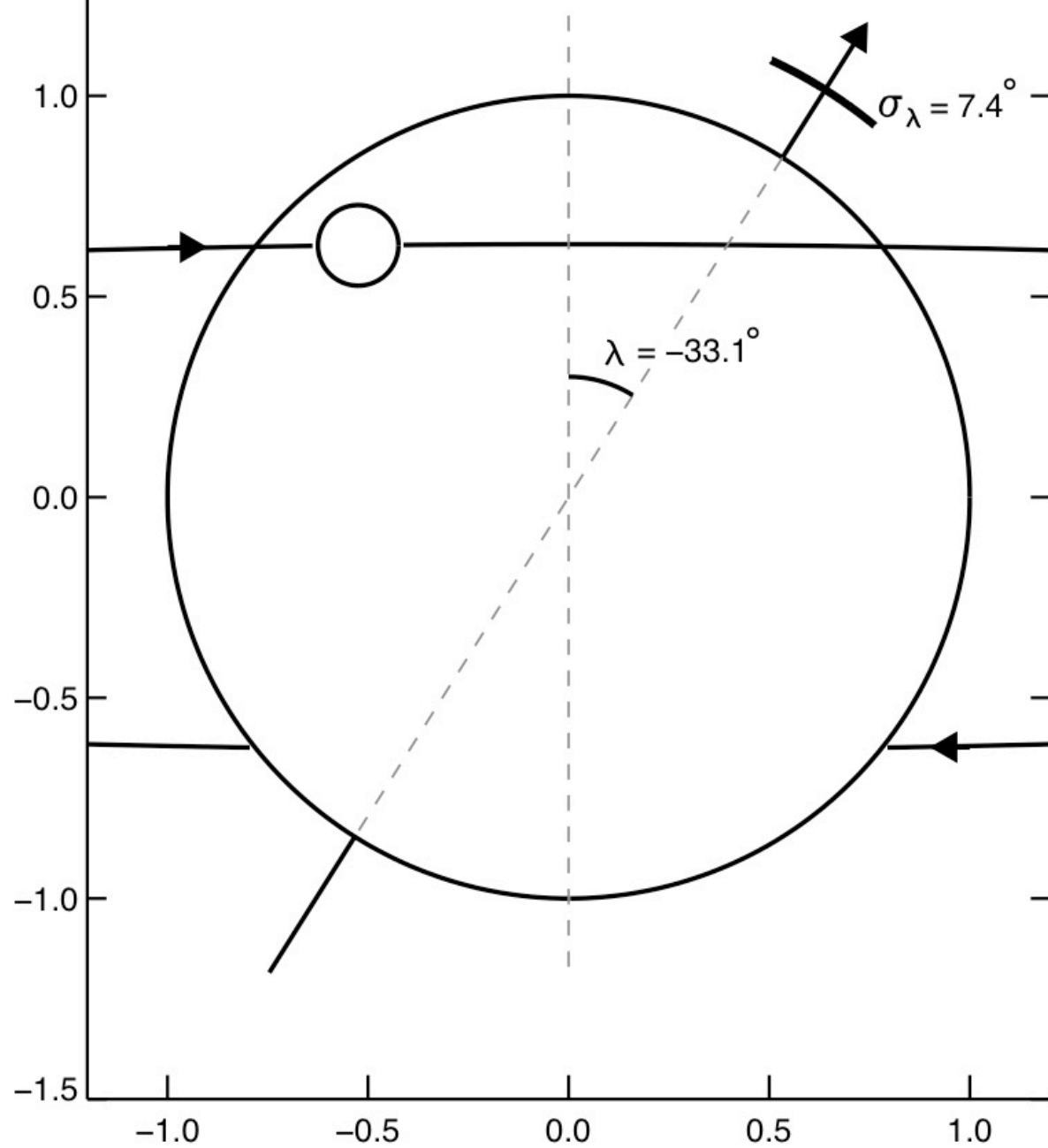
HAT-P-1

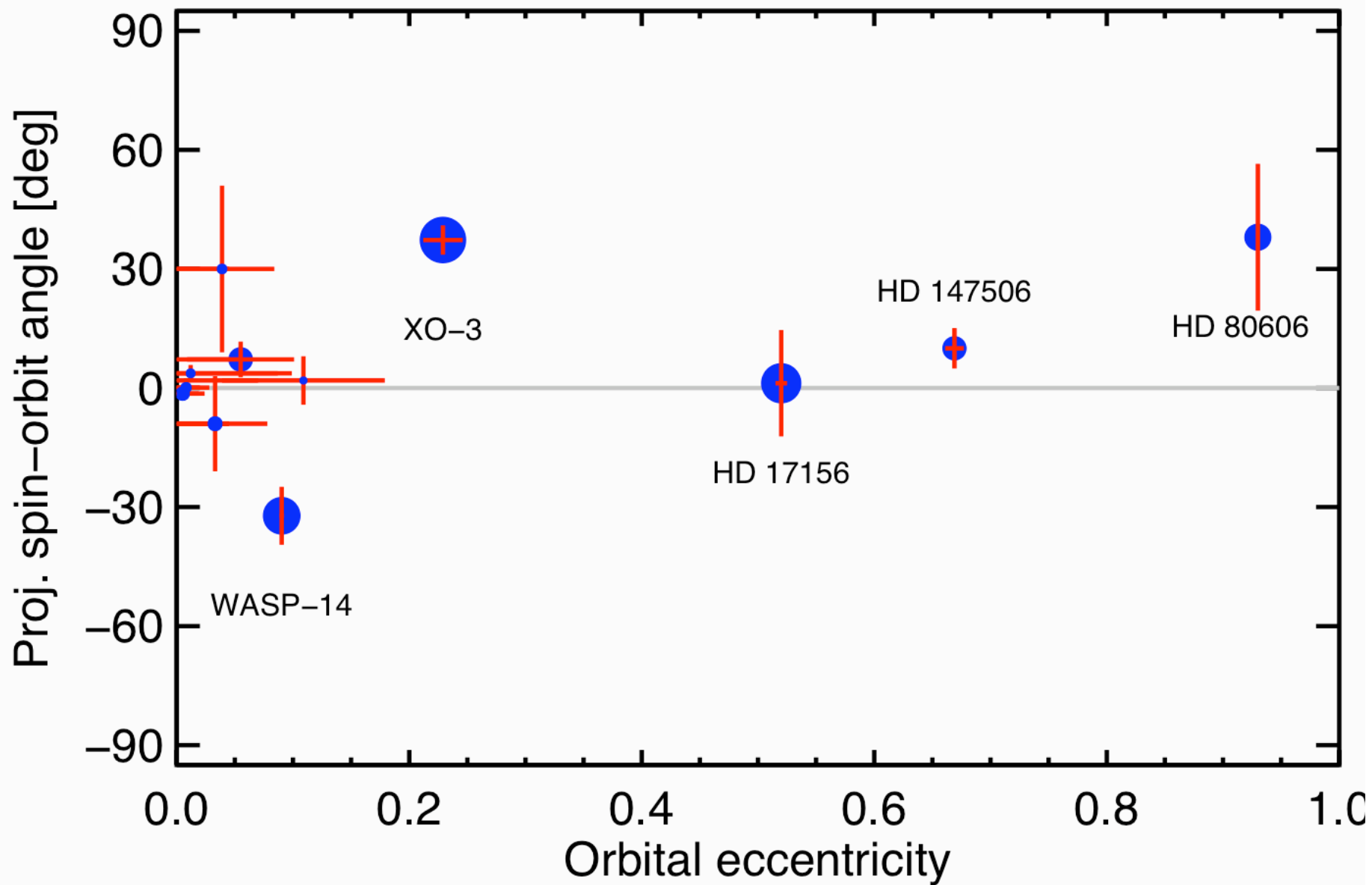
Johnson, Winn, Narita et al. 2008





WASP-14 Spin-Orbit Configuration





Star/planet
contrast:

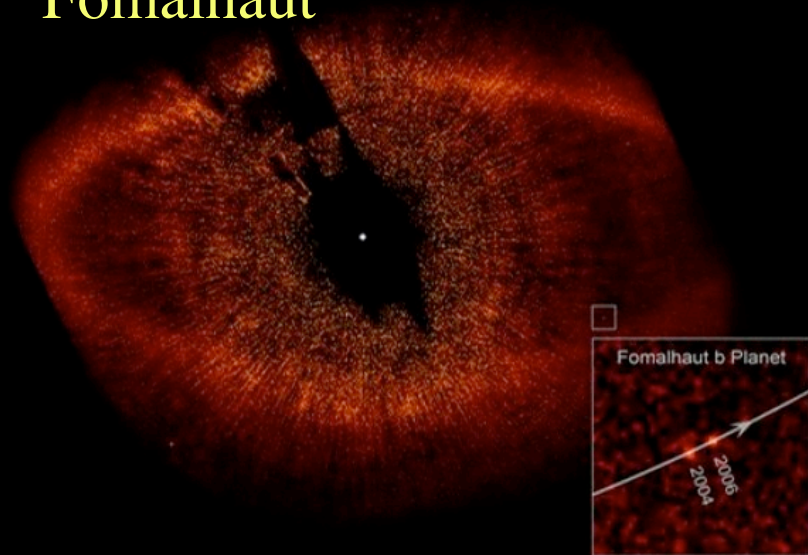
10^5 to 10^9

Person holding
a lit match

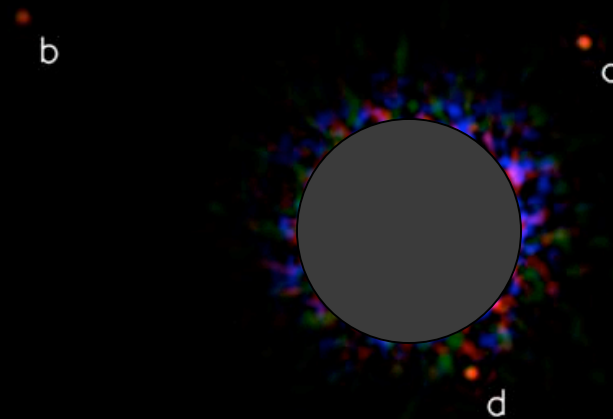




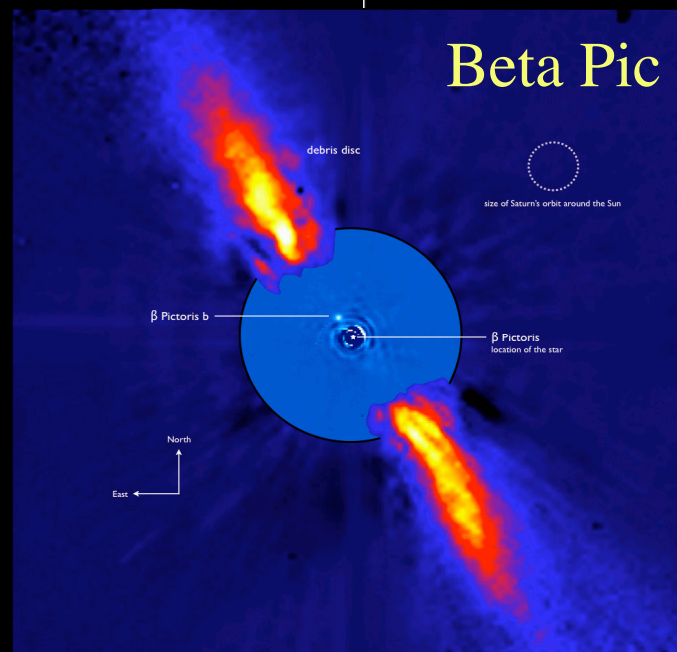
Fomalhaut

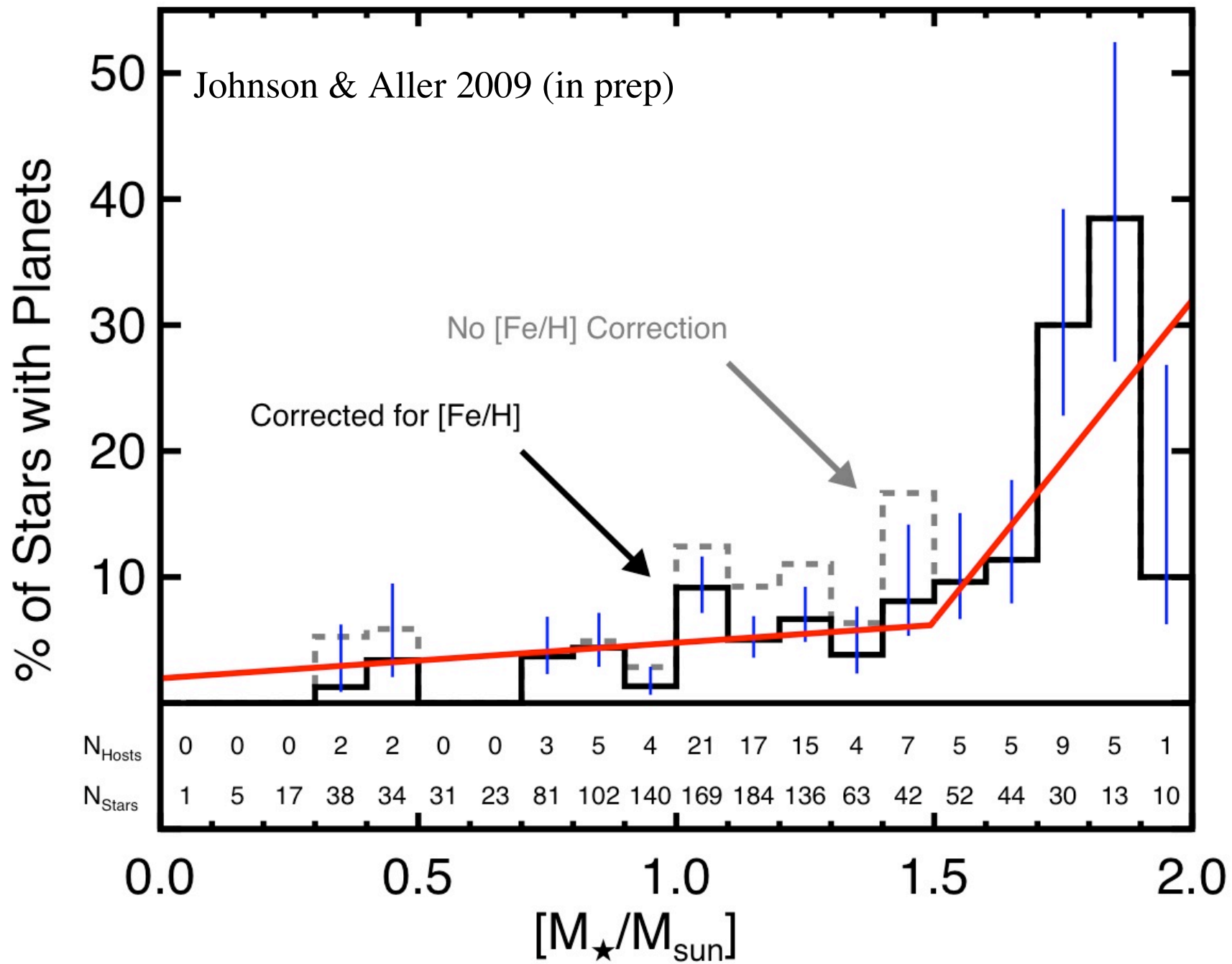


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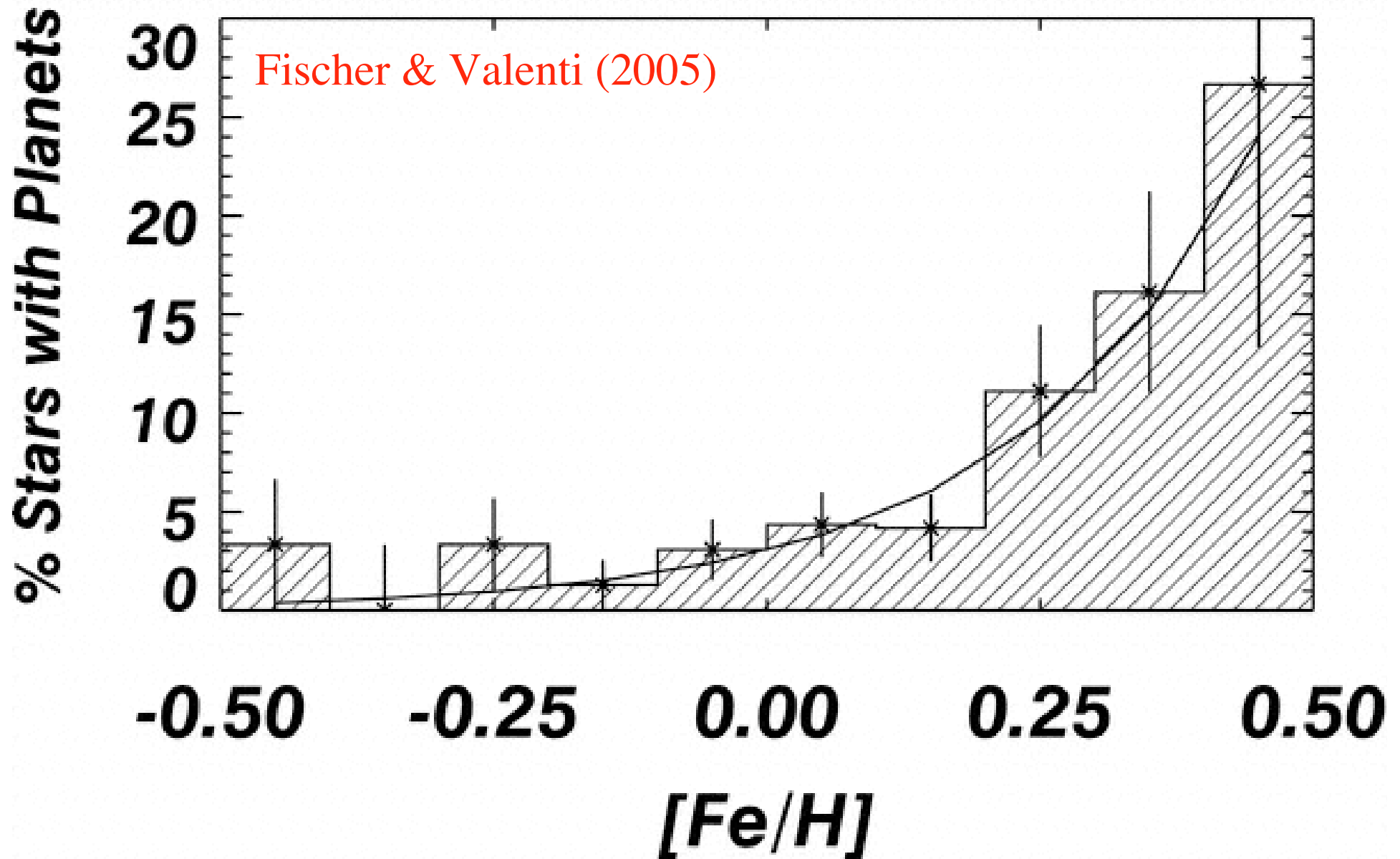


Beta Pic

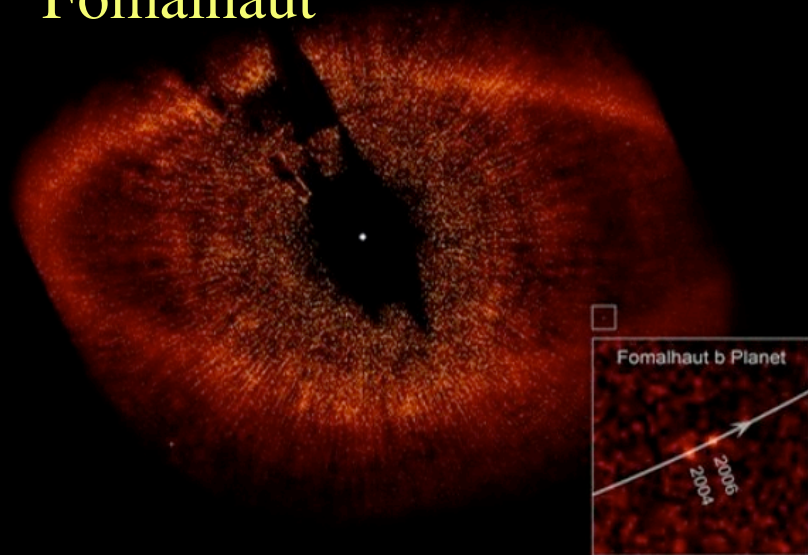




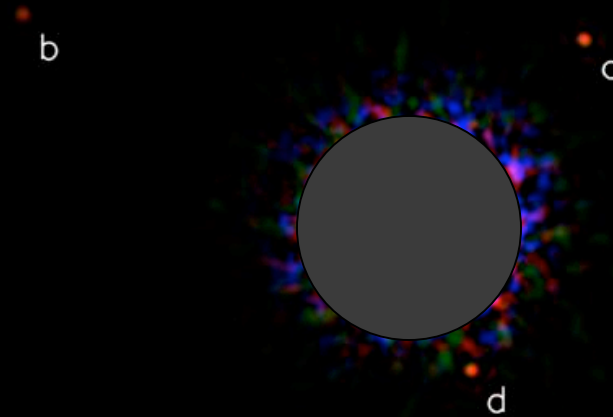
The Planet-Metallicity Correlation



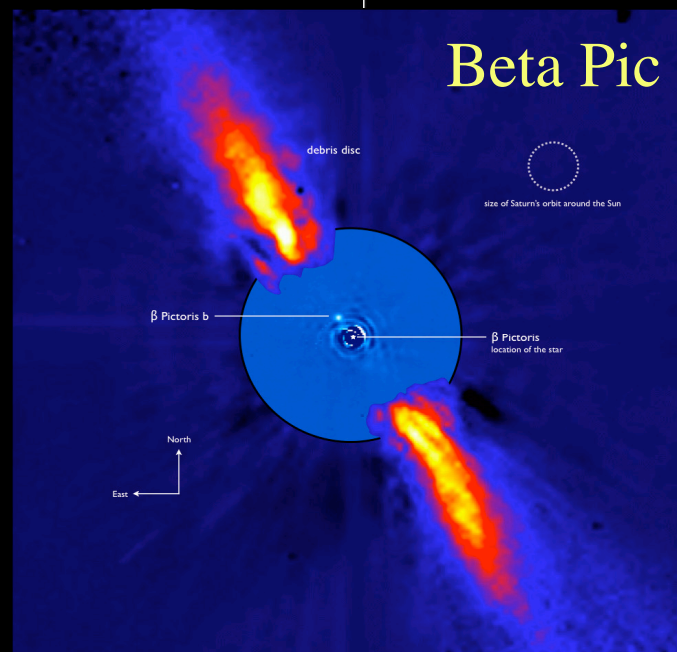
Fomalhaut



HR8799

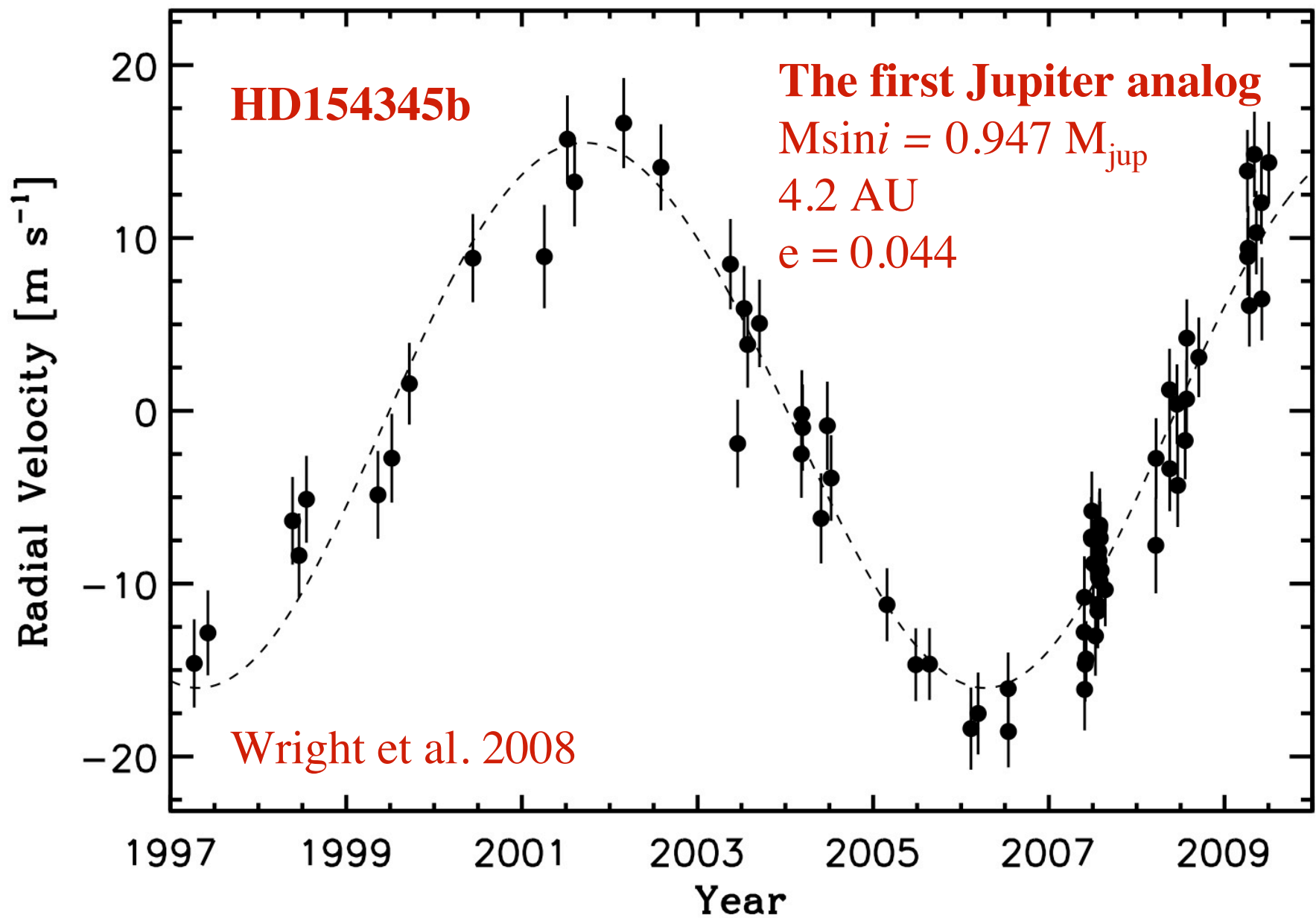


Beta Pic



What we know now

- Planets are eccentric, orbit at all semimajor axes, and have a wide range of masses
- Planets have a wide variety of internal structures
- Some planets are misaligned
- Multiplanet systems are common
- Planets are more common around high-mass and/or high-metallicity stars



Thank You.

And Thanks to My Collaborators:

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Kathryn Peek (Berkeley)

