The Dynamics of Hot Jupiters: Tales Told by Transits

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Collaborators:
Scott Tremaine
Josh Winn
Matt Holman
EPOXI team

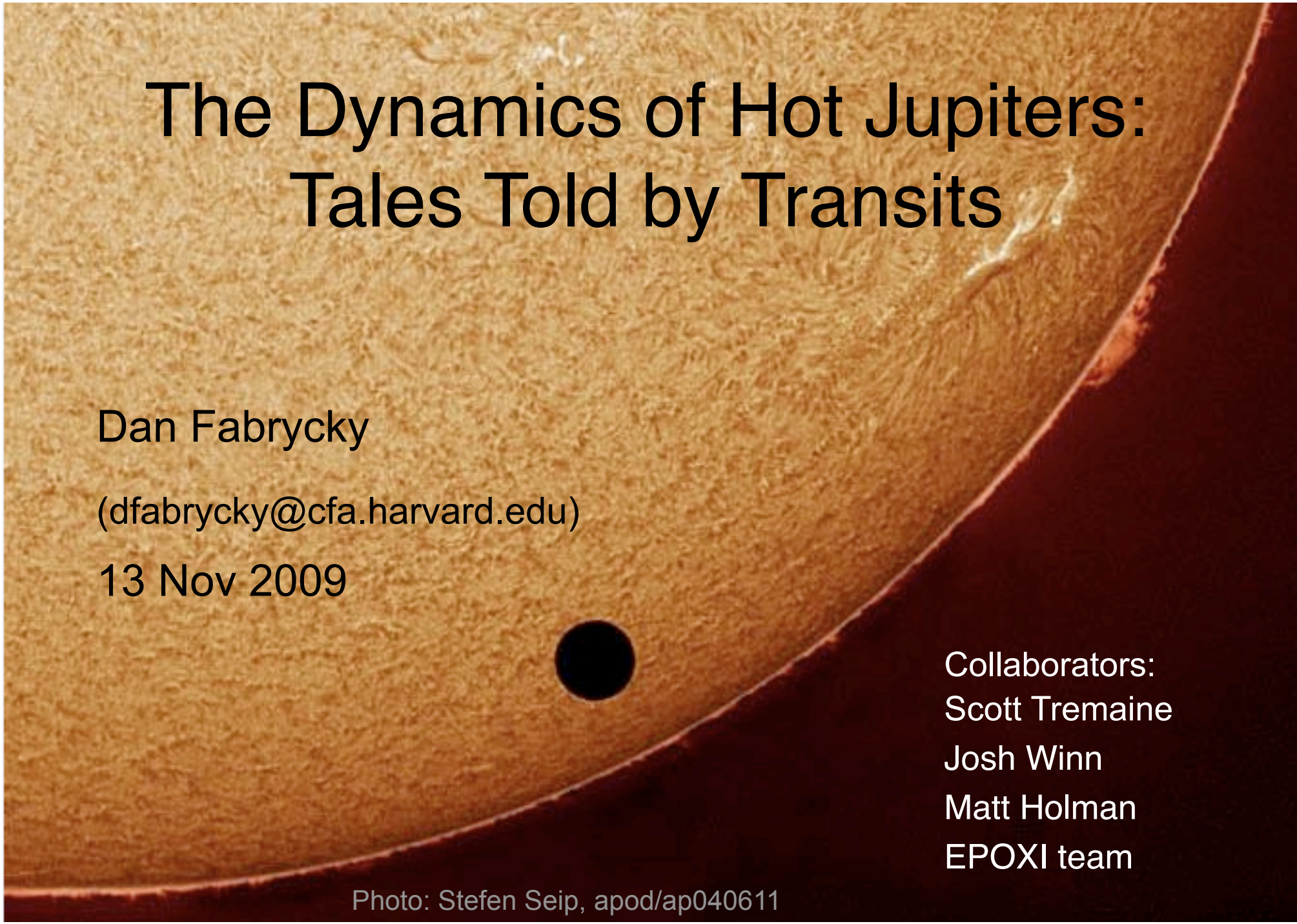
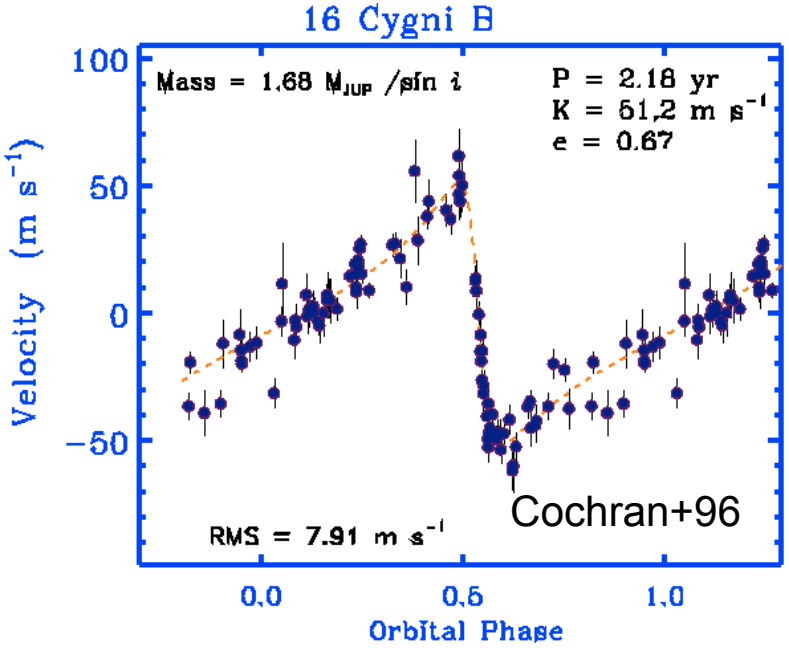
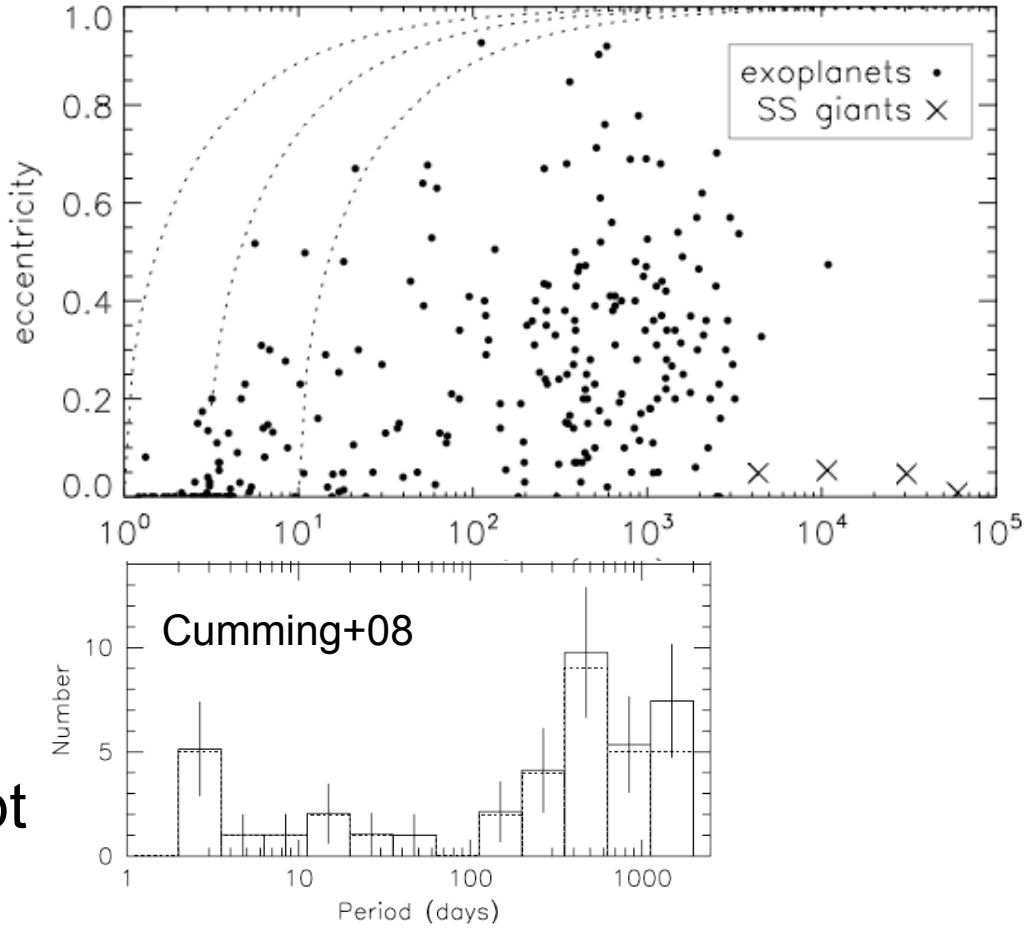


Photo: Stefen Seip, apod/ap040611

Radial Velocity Planets: Orbital Properties





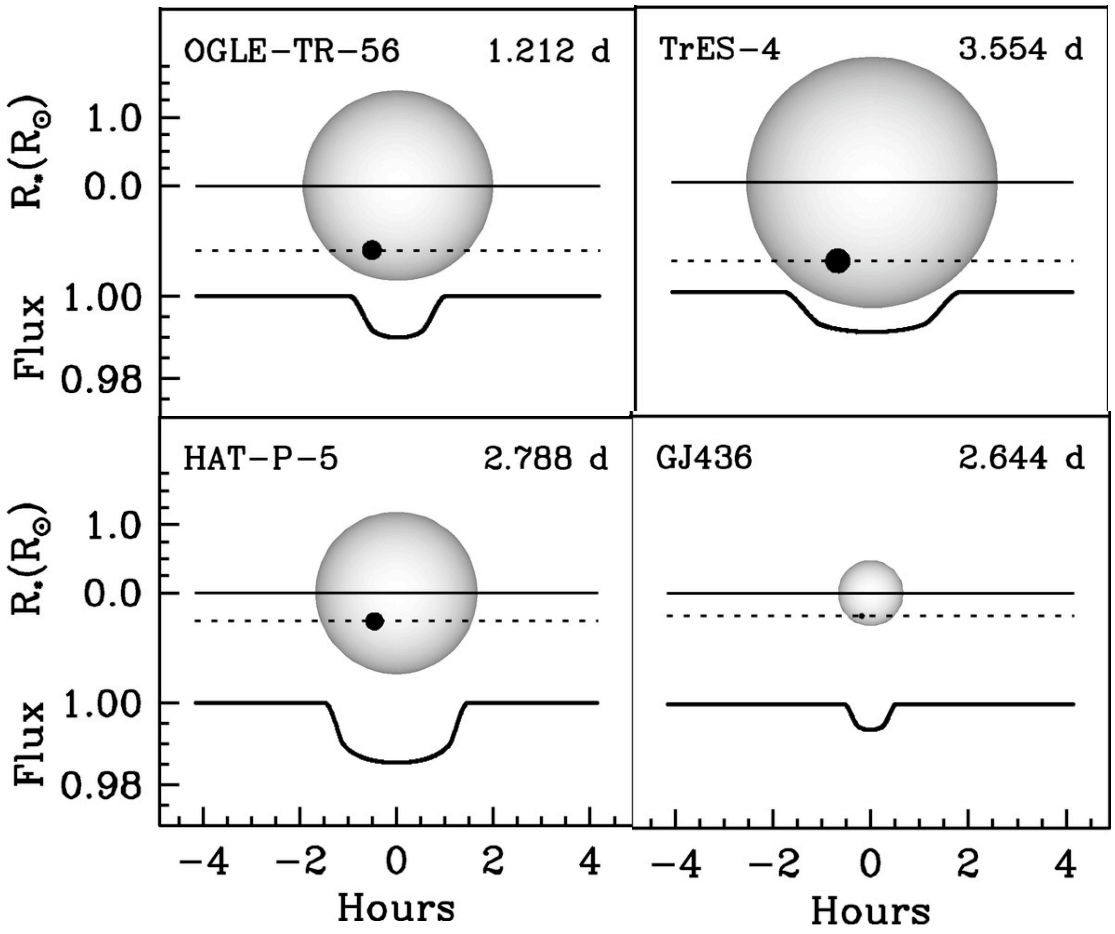
The two main surprises:

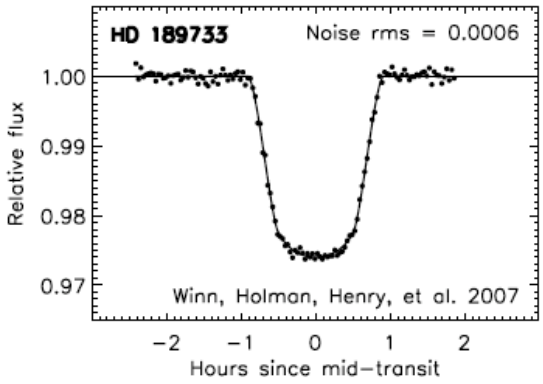
Large eccentricities, except when tidally damped

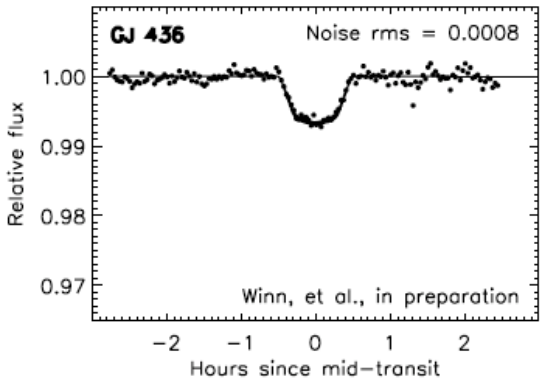
Small periods for gas giants

Hot Jupiters are a Sub-class

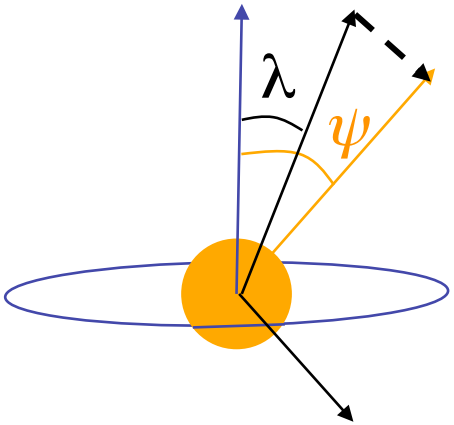
Transiting planets



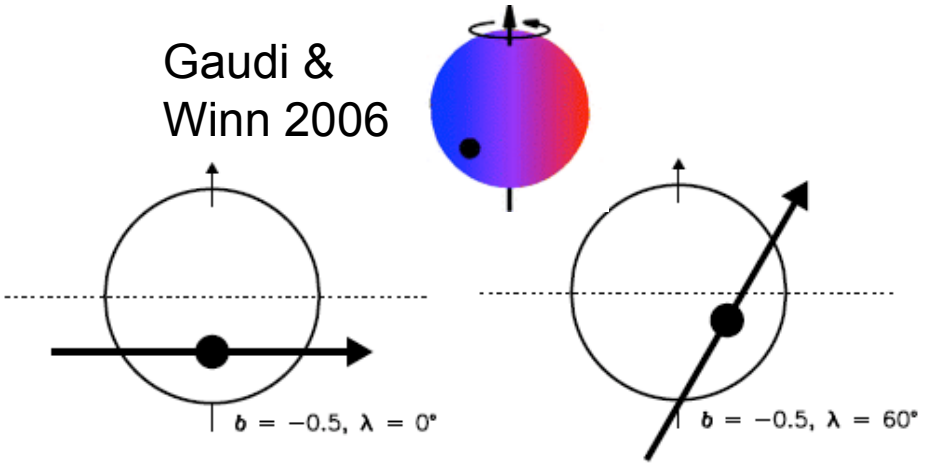


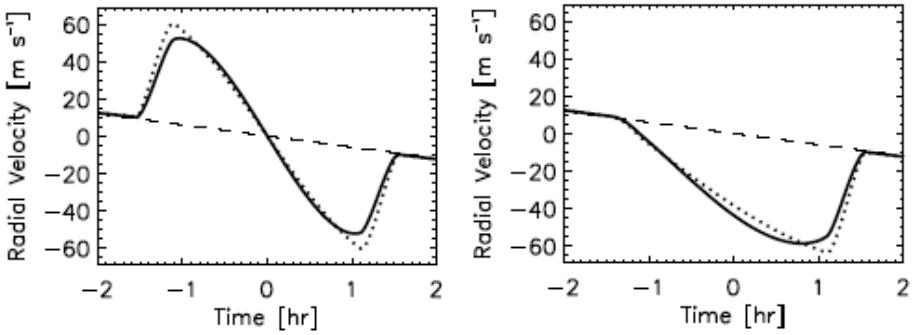


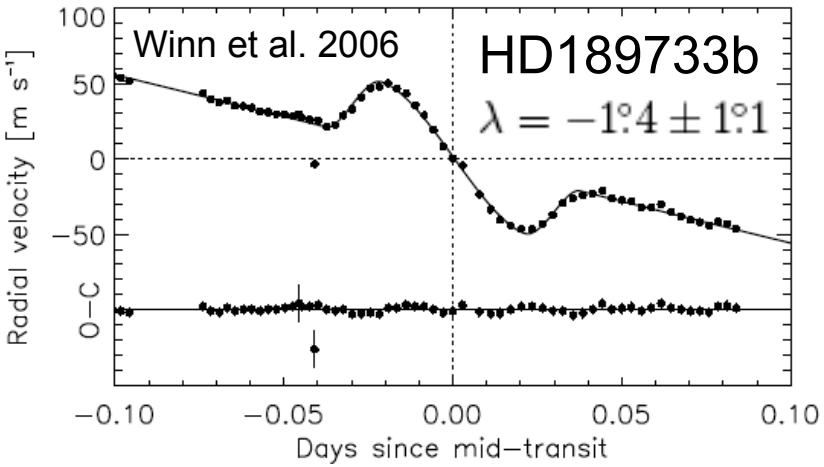
Measuring stellar obliquity



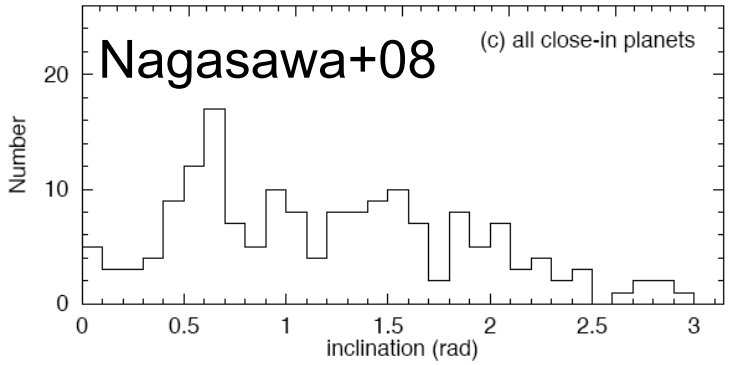
Gaudi & Winn 2006

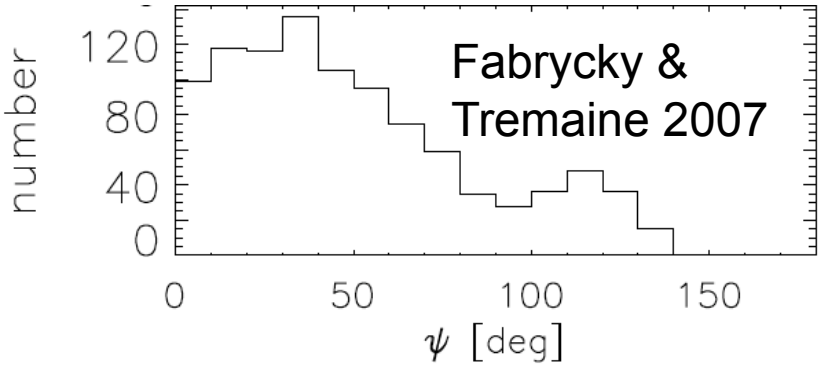


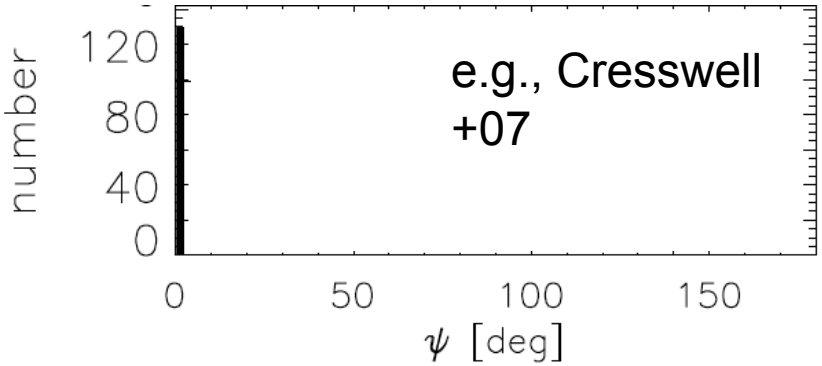




Theoretical Predictions

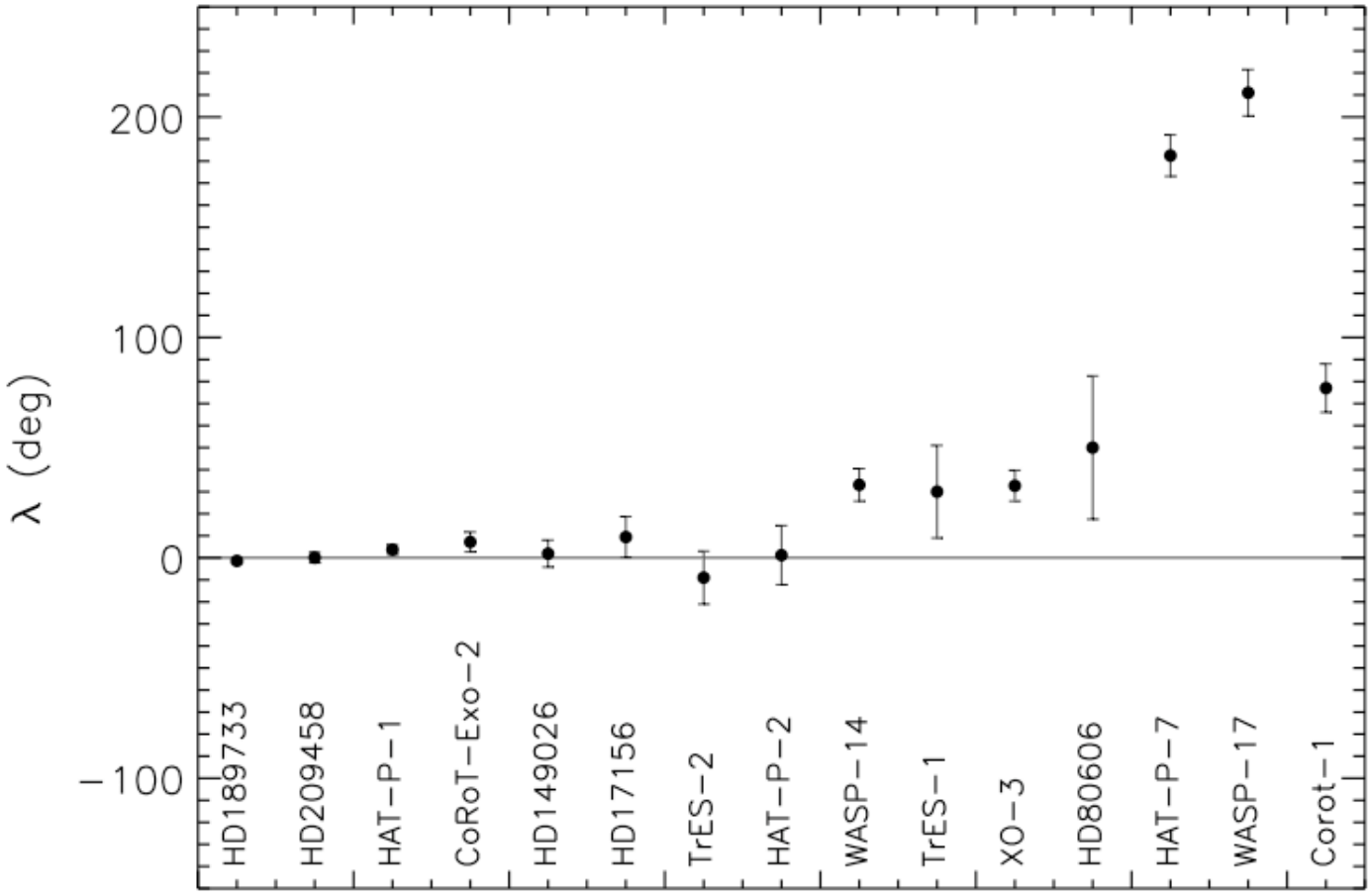




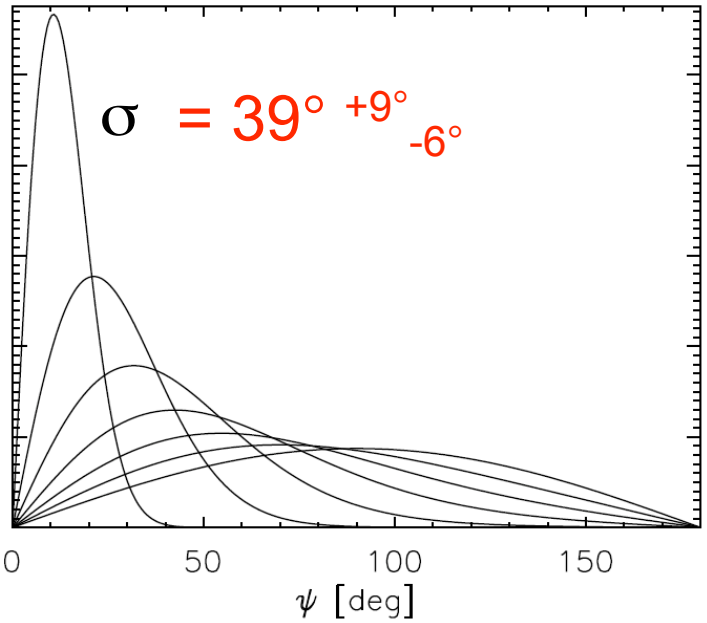


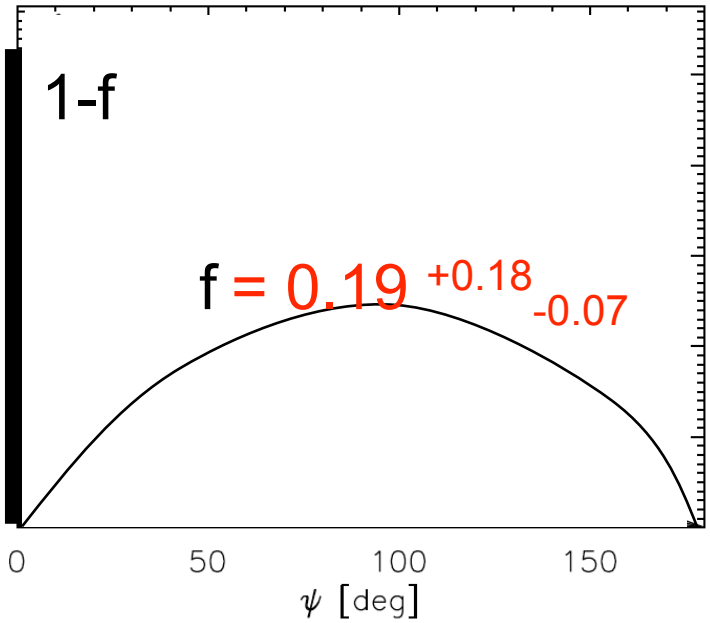
- Planet-planet scattering with tidal friction
- Kozai cycles with tidal friction
- Disk migration

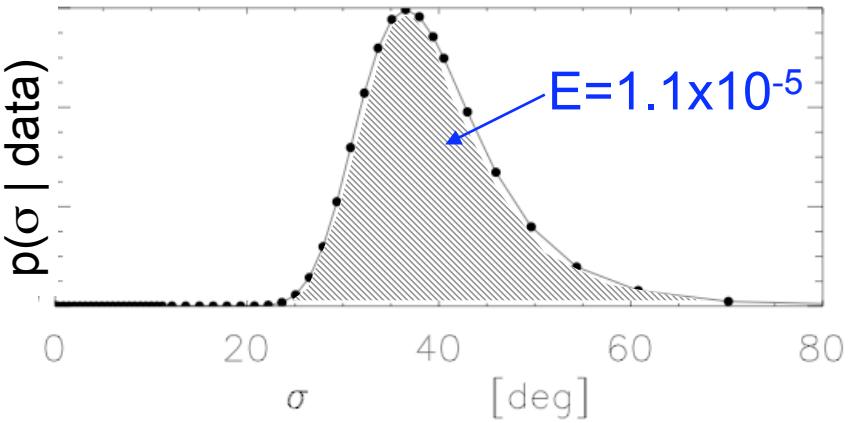
Spin-orbit observations…

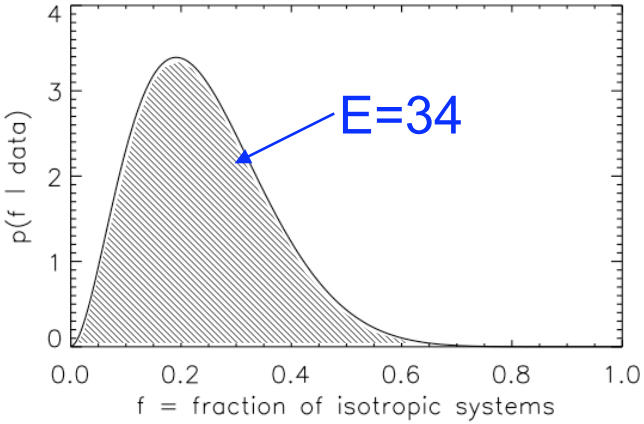


ψ distributions





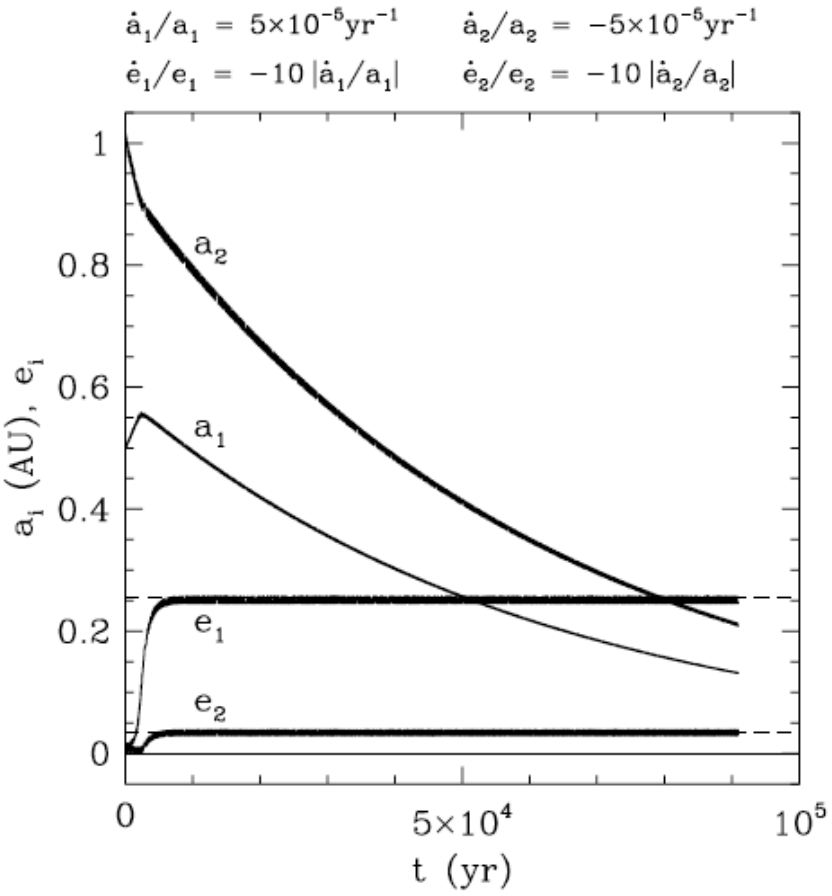




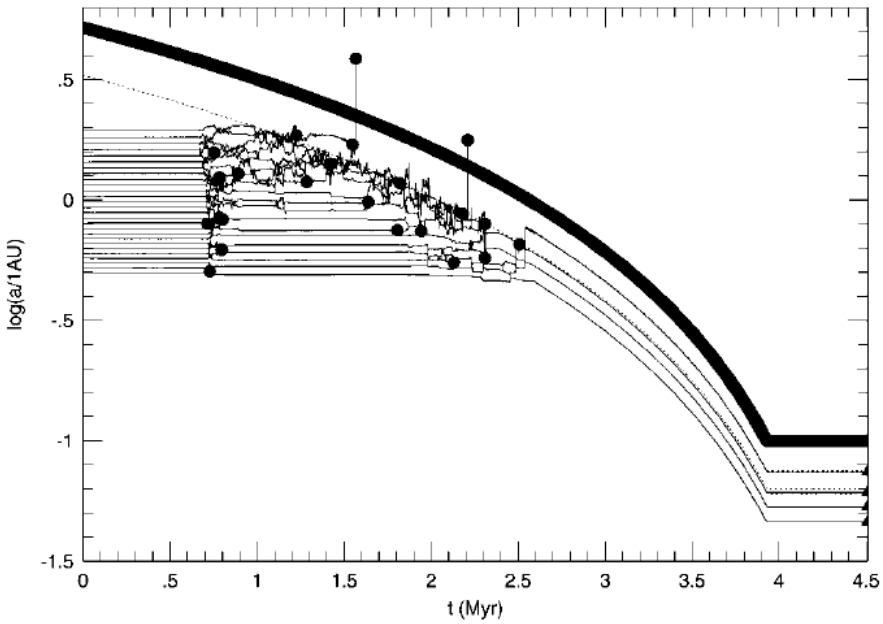
Two migration mechanisms?

Fabrycky & Winn 2009

Disk migration predicts resonant systems

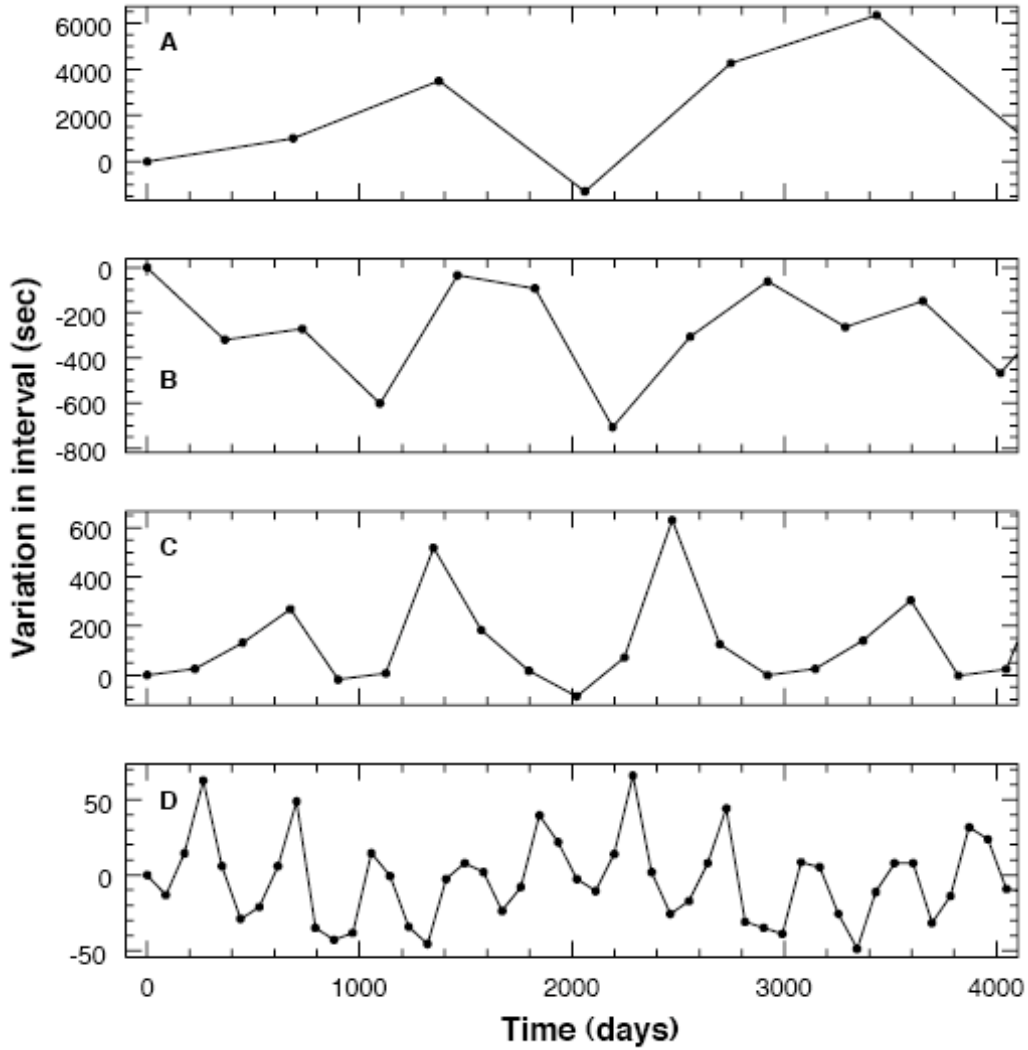


Lee & Peale 2002; GJ 876 bc



Zhou+05; terrestrial trapping

Transit Time Variation: Solar System



Mars

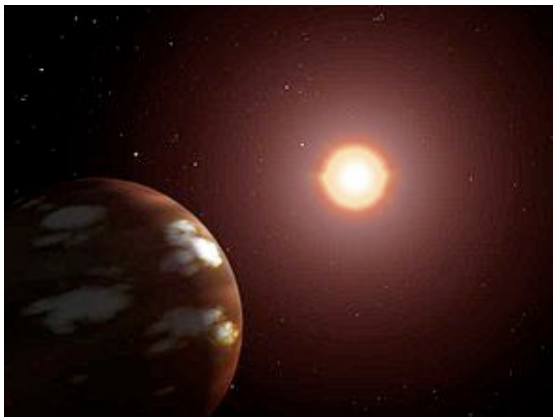
Earth

Venus

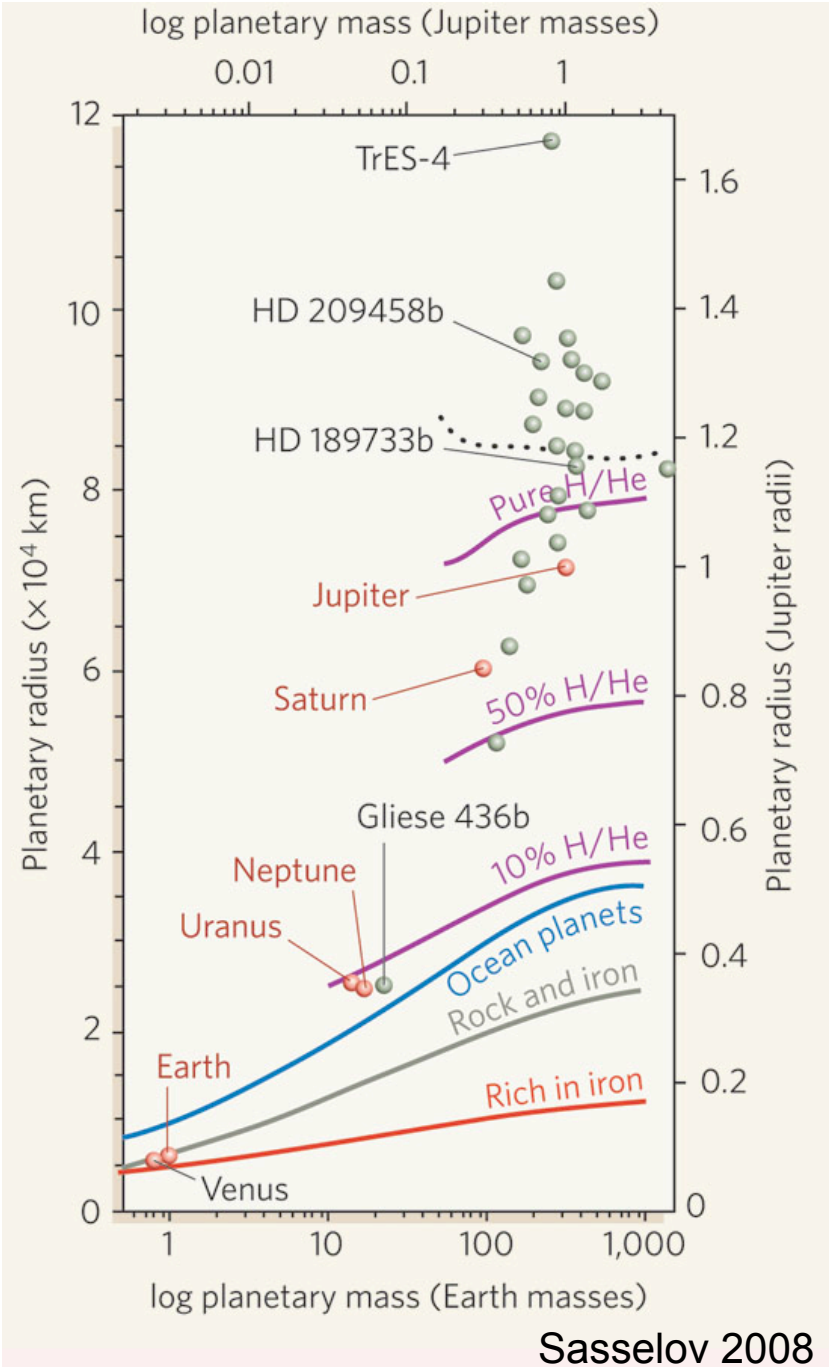
Mercury

Murray & Holman 2005, Agol et al. 2005

GJ 436 b

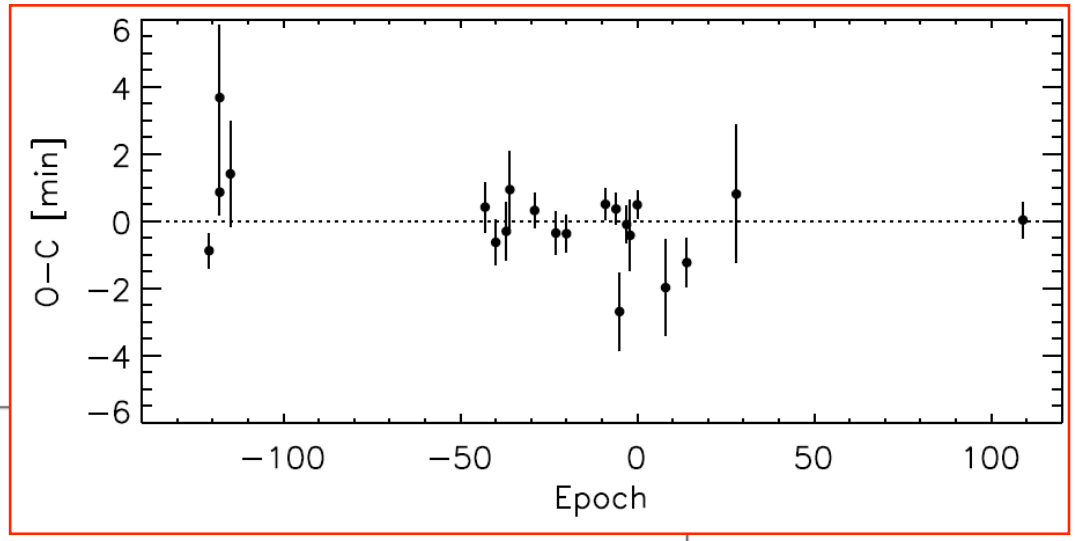


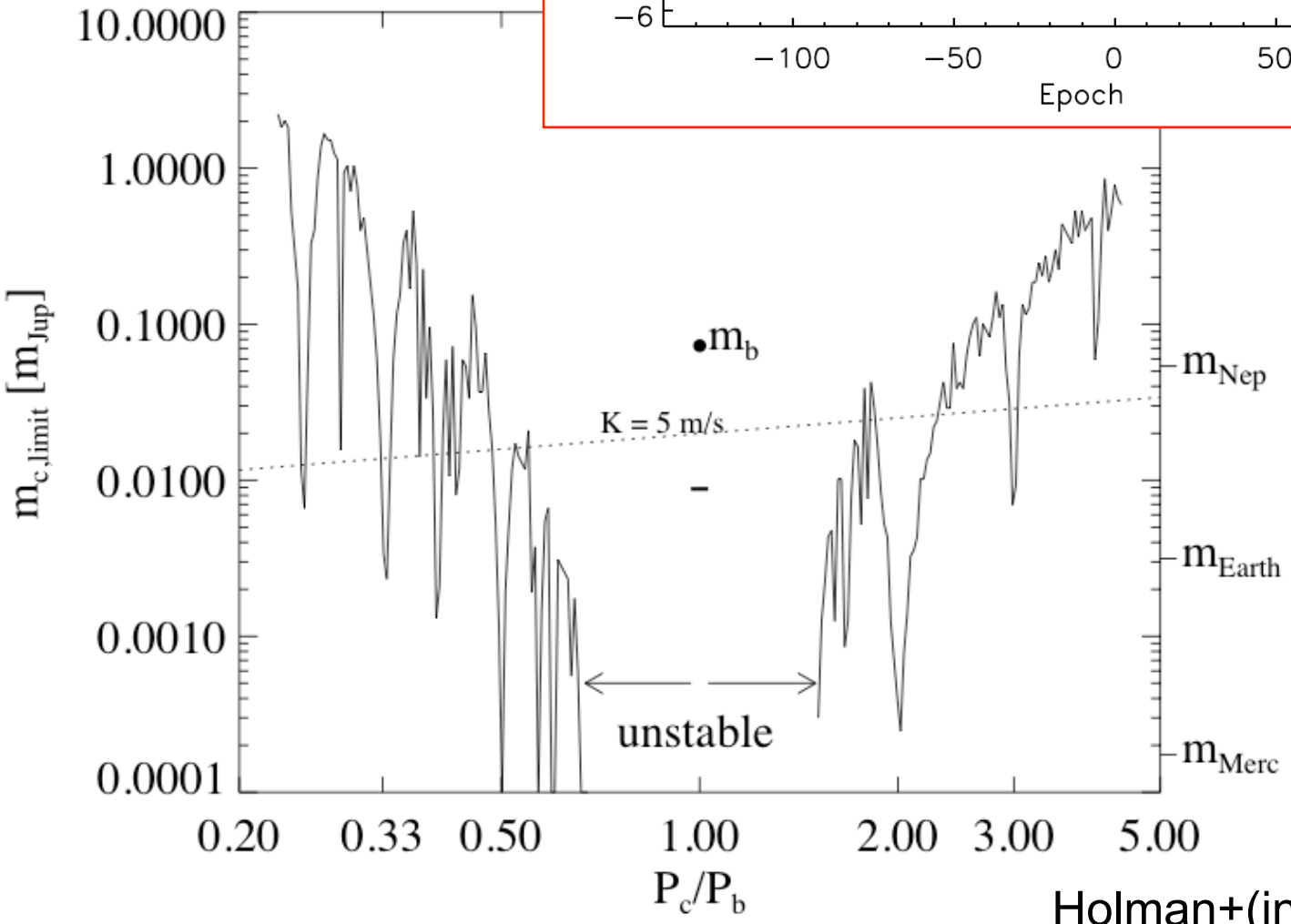
- P=2.64 d
- e=0.15
- => Q > 10 Q_{Uranus}



Sasselov 2008

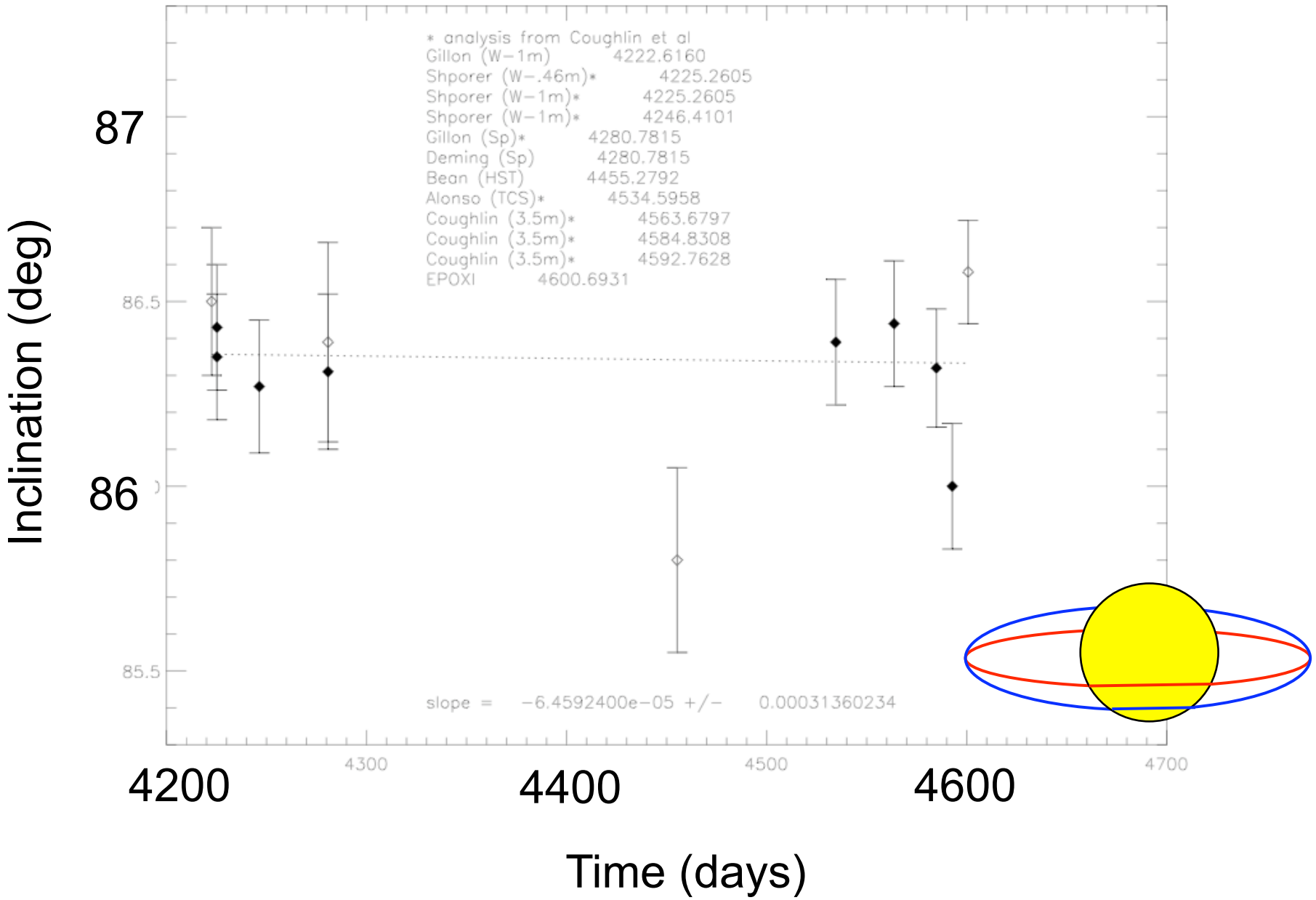
TTV Constraints on GJ436c



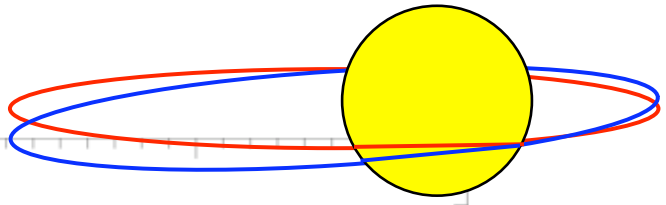


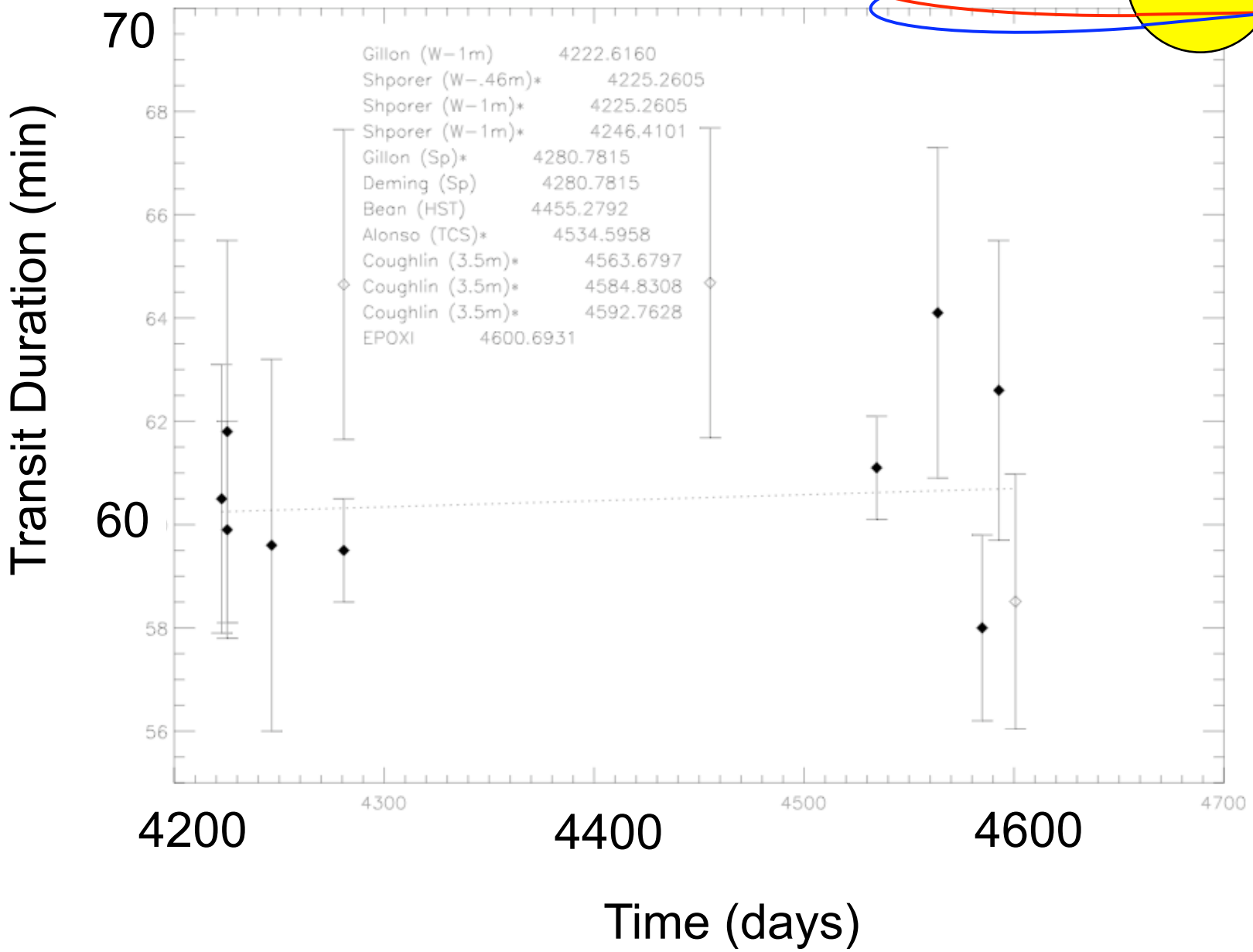
Holman+(in prep)

TIV Constraints on GJ436c

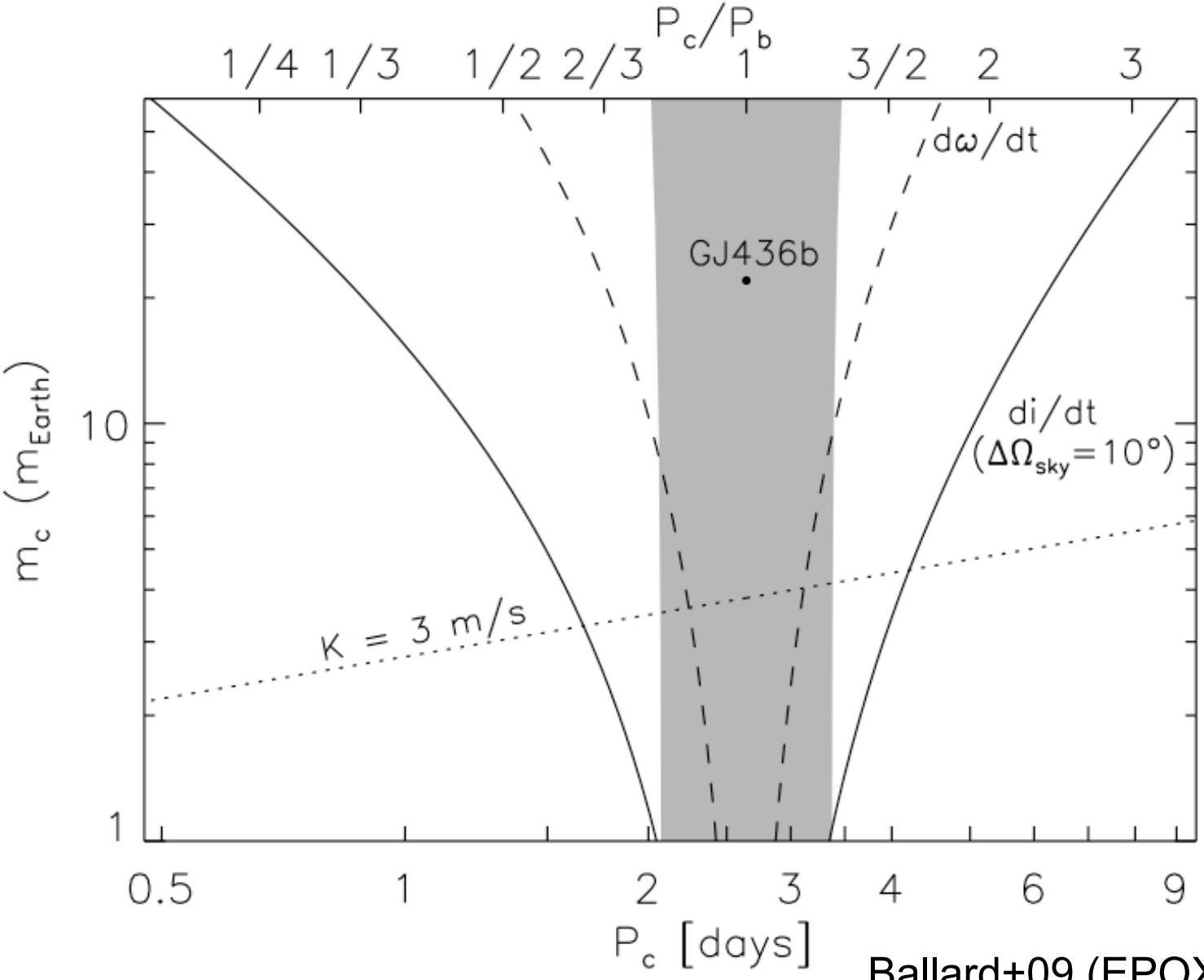


TDV Constraints on GJ436c





TIV/TDV Constraints on GJ436c

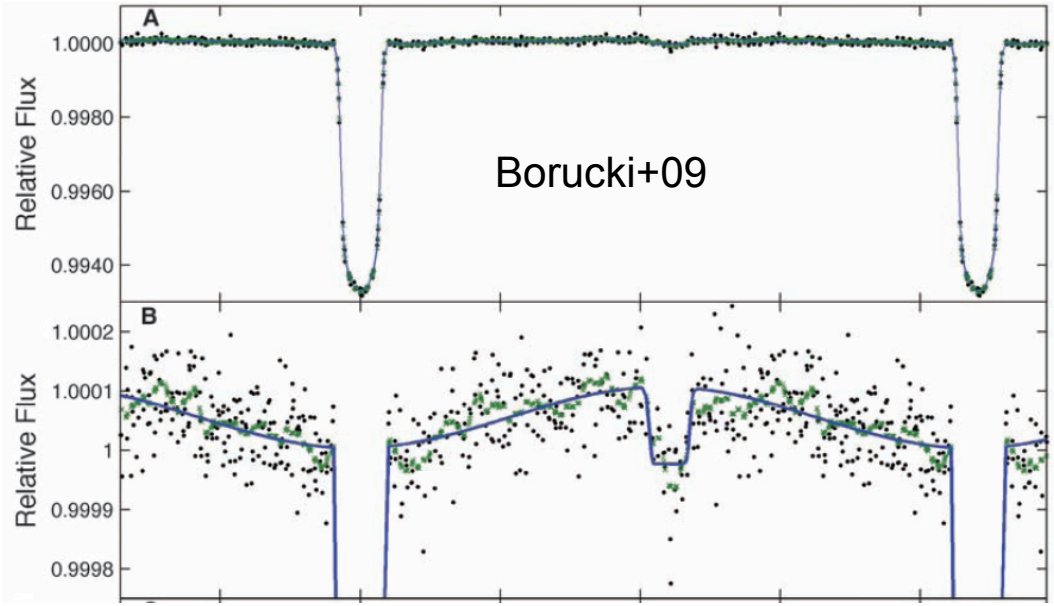


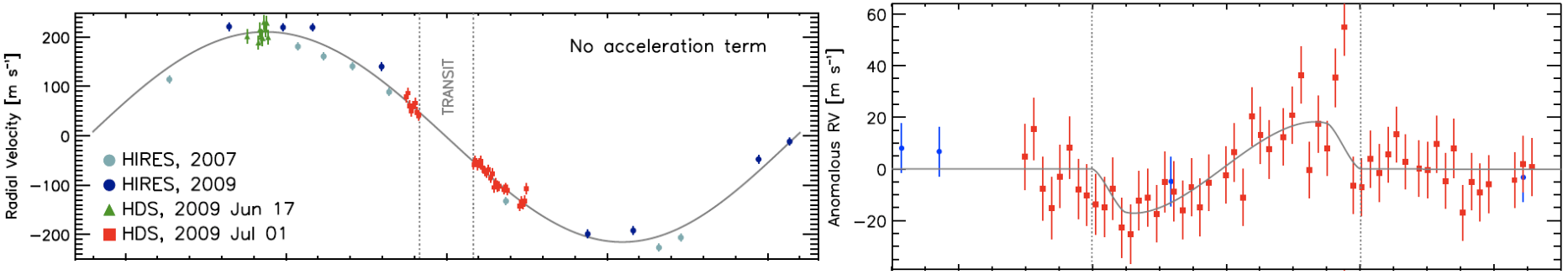
Ballard+09 (EPOXI team)

Kepler's Promise: I. Known systems

The case of HAT-P-7:

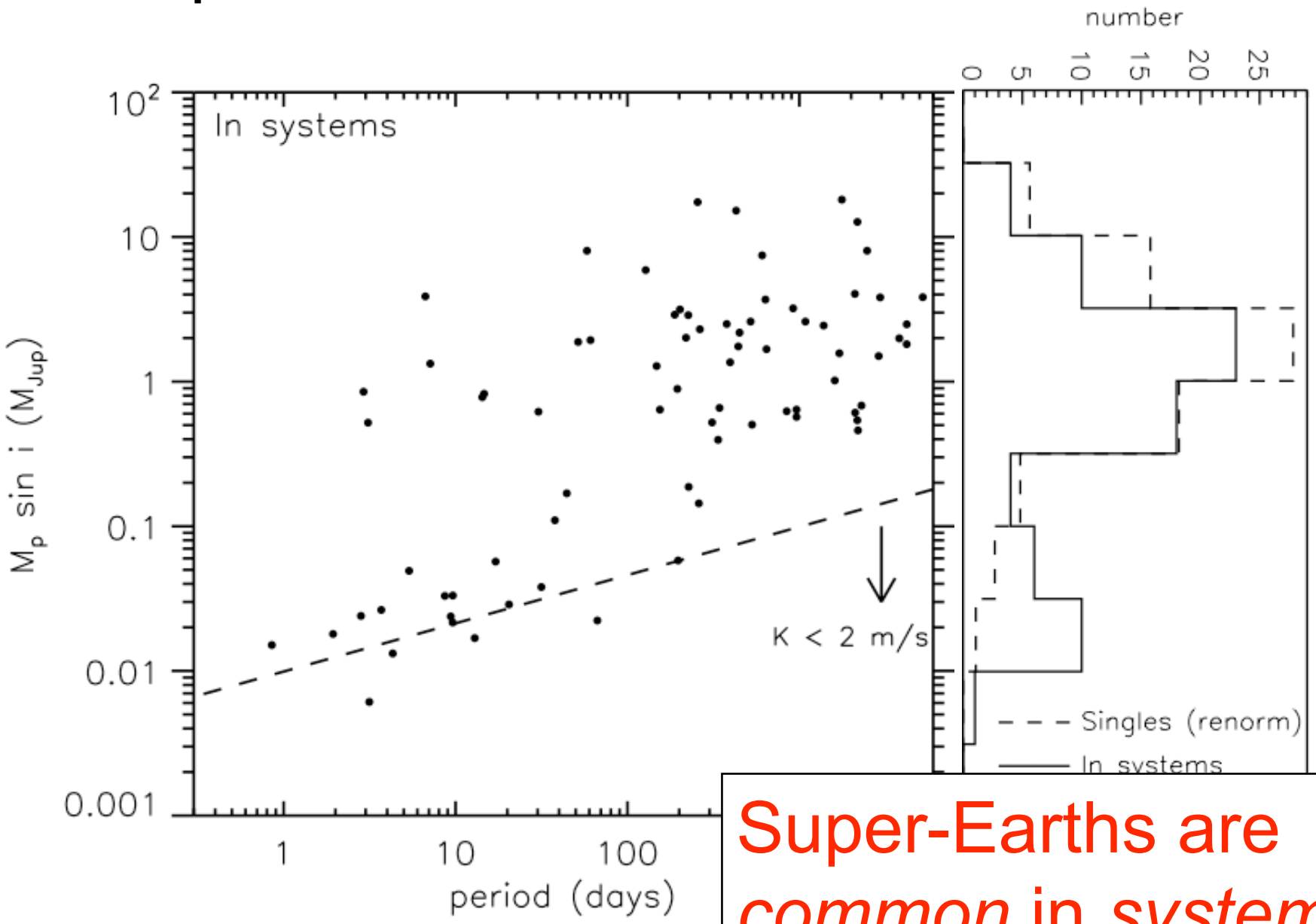
- Transits (in Kepler field!)
- Second planet or star
- Misaligned Spin-Orbit





Winn+09

Kepler's Promise: II. To-be discovered



Super-Earths are *common* in *systems*

Summary

- The results of radial velocity surveys have prompted us to construct explanatory theories of hot Jupiter migration.
- Transit surveys are providing the new constraints to those theories.
- Hot Jupiters were fun; Super-Earths will be more fun, with *Kepler*