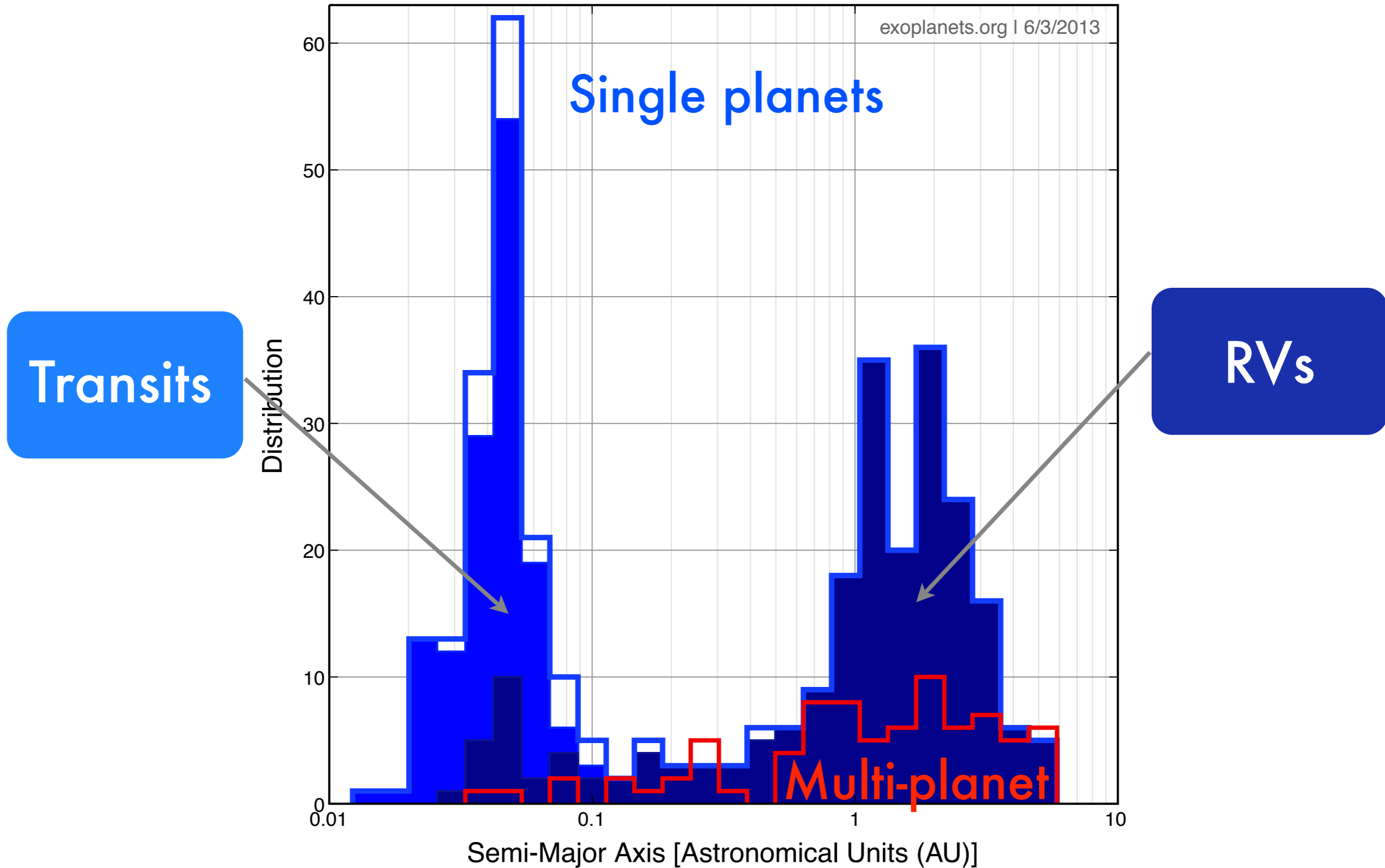# Dynamical evolution of planetary systems

PLATO's contribution

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Orbital characteristics of giant planets

exoplanets.org I 6/3/2013

Single planets

Transits

RVs

Multi-planet

Distribution

Semi-Major Axis [Astronomical Units (AU)]

Hot Jupiters

- How do they form?
  - not in situ, beyond the ice line ...
- How do they migrate?
  - planet-disc interaction and/or planet-planet scattering?
- What stops the migration?
  - the magnetospheric cavity of a protoplanetary disc?
- How long can they survive?
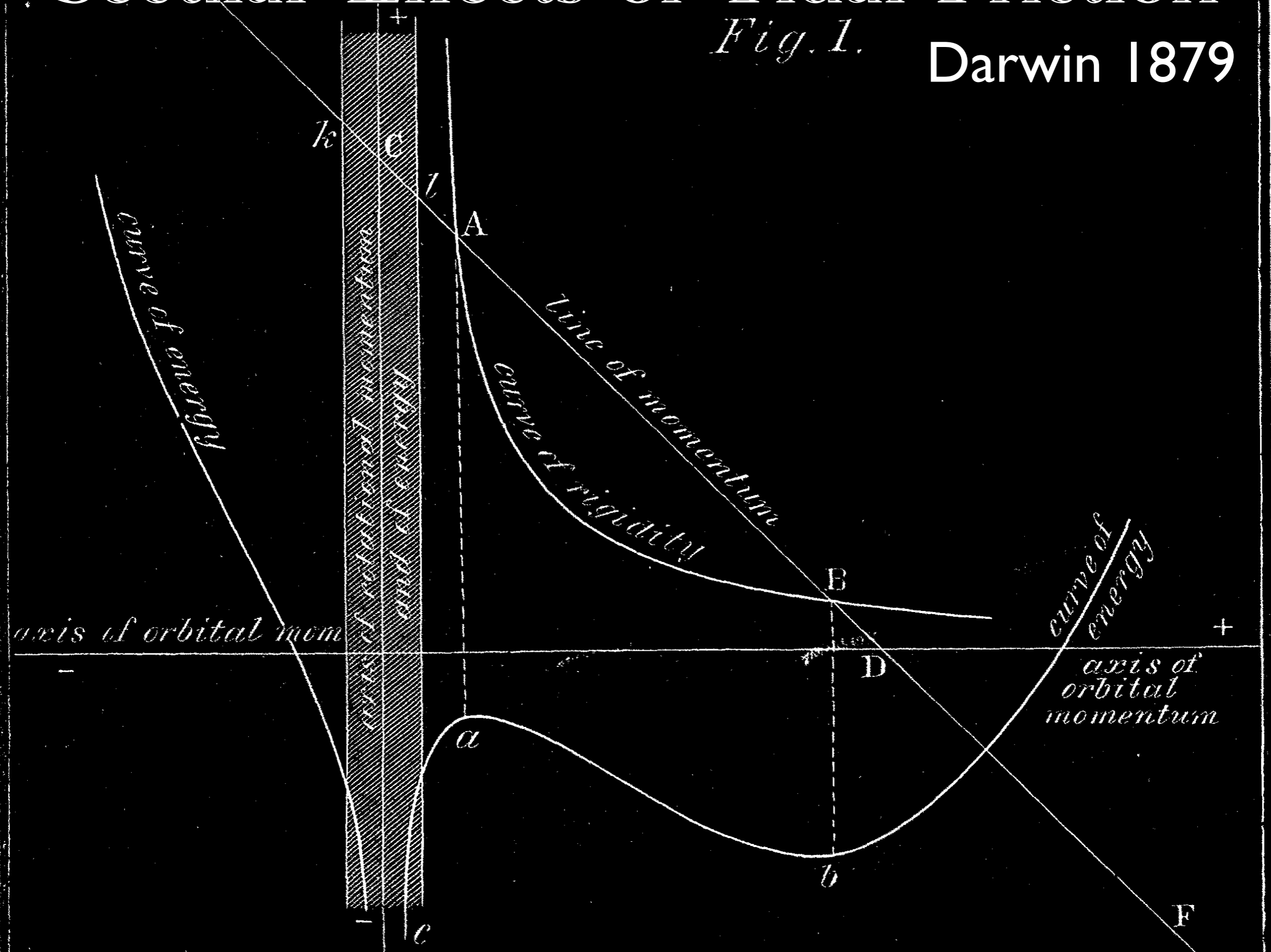 - how strong are the tides?

Disk

No disk

Secular Effects of Tidal Friction
Fig. 1.
Darwin 1879

Fig. 1.

Darwin 1879

Retrograd system

Unstable equilibrium

Stable equilibrium

E

+

k

C

A

curve of energy

exchange of momentum and of rigidity

line of momentum

curve of rigidity

curve of energy
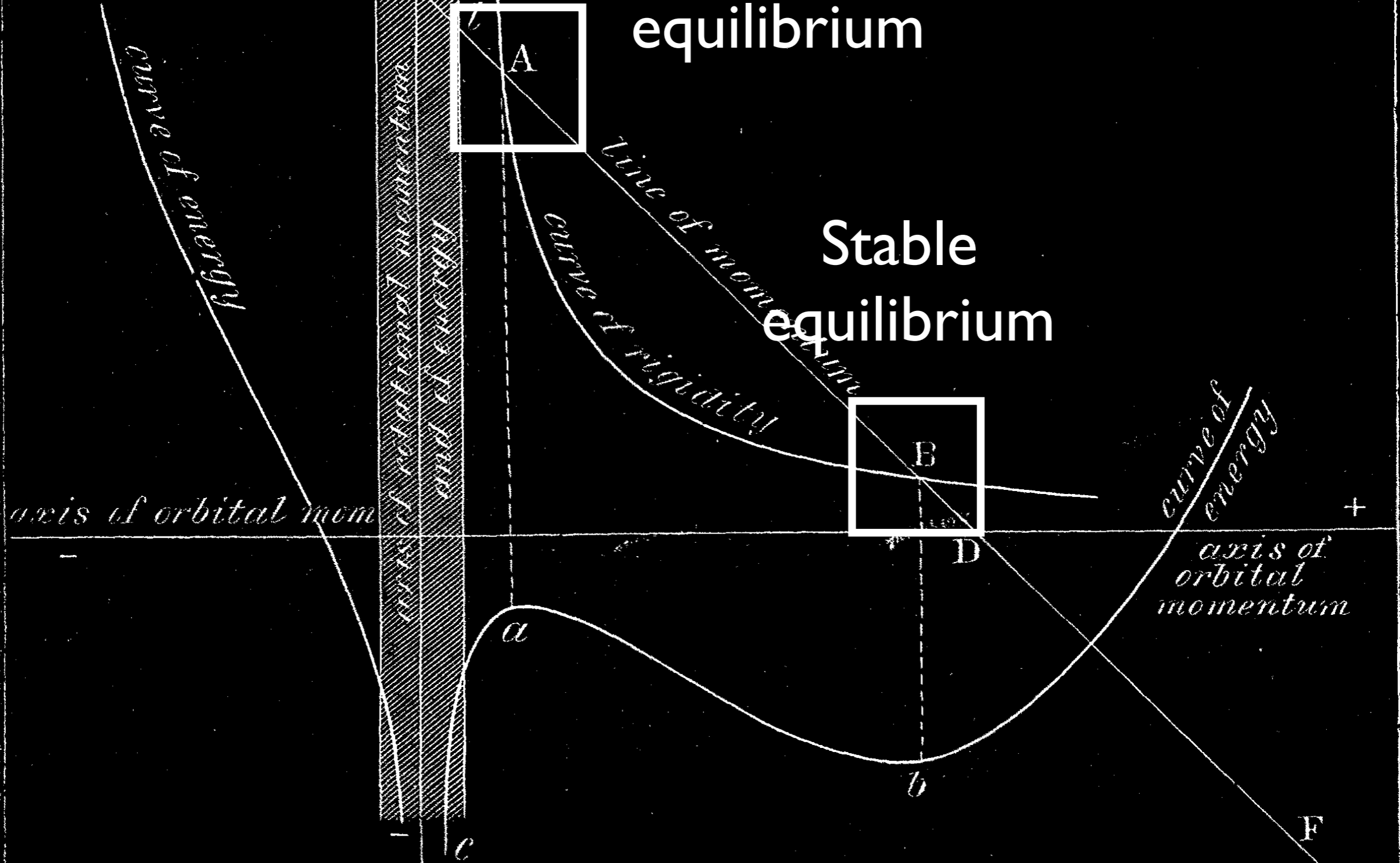
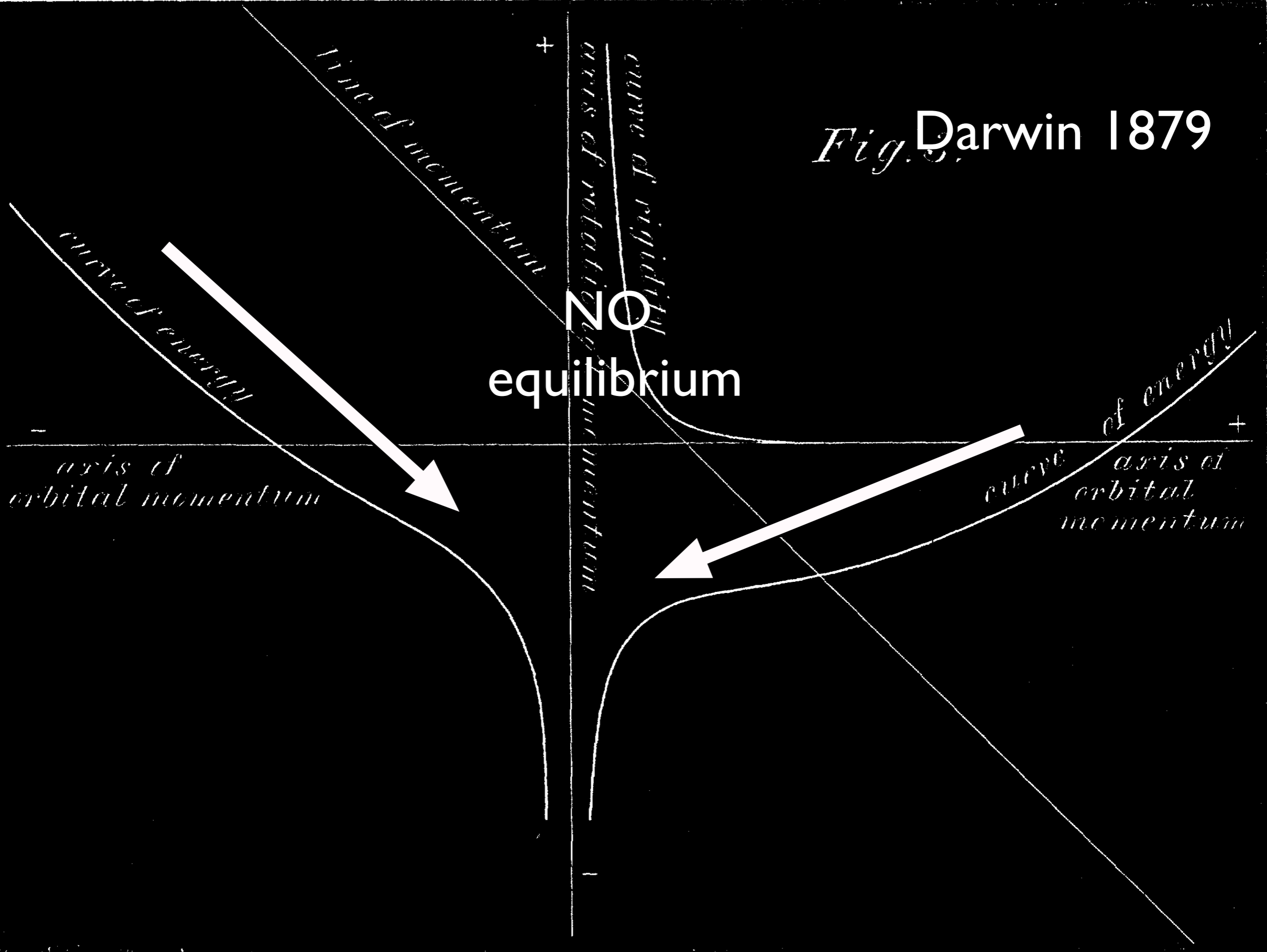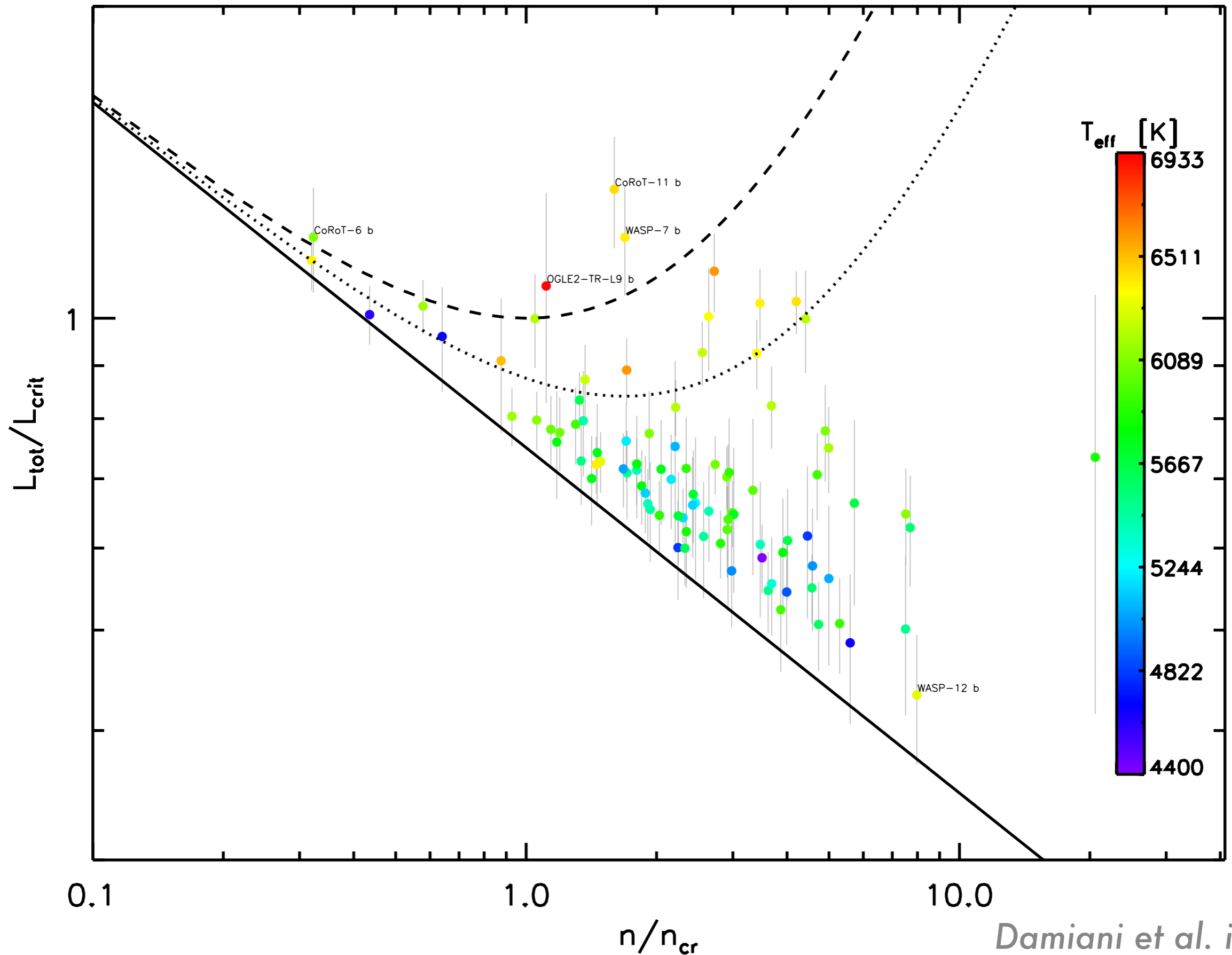B

D

axis of orbital mom

axis of orbital momentum

−

+

a

b

c

F

Fig. Darwin 1879

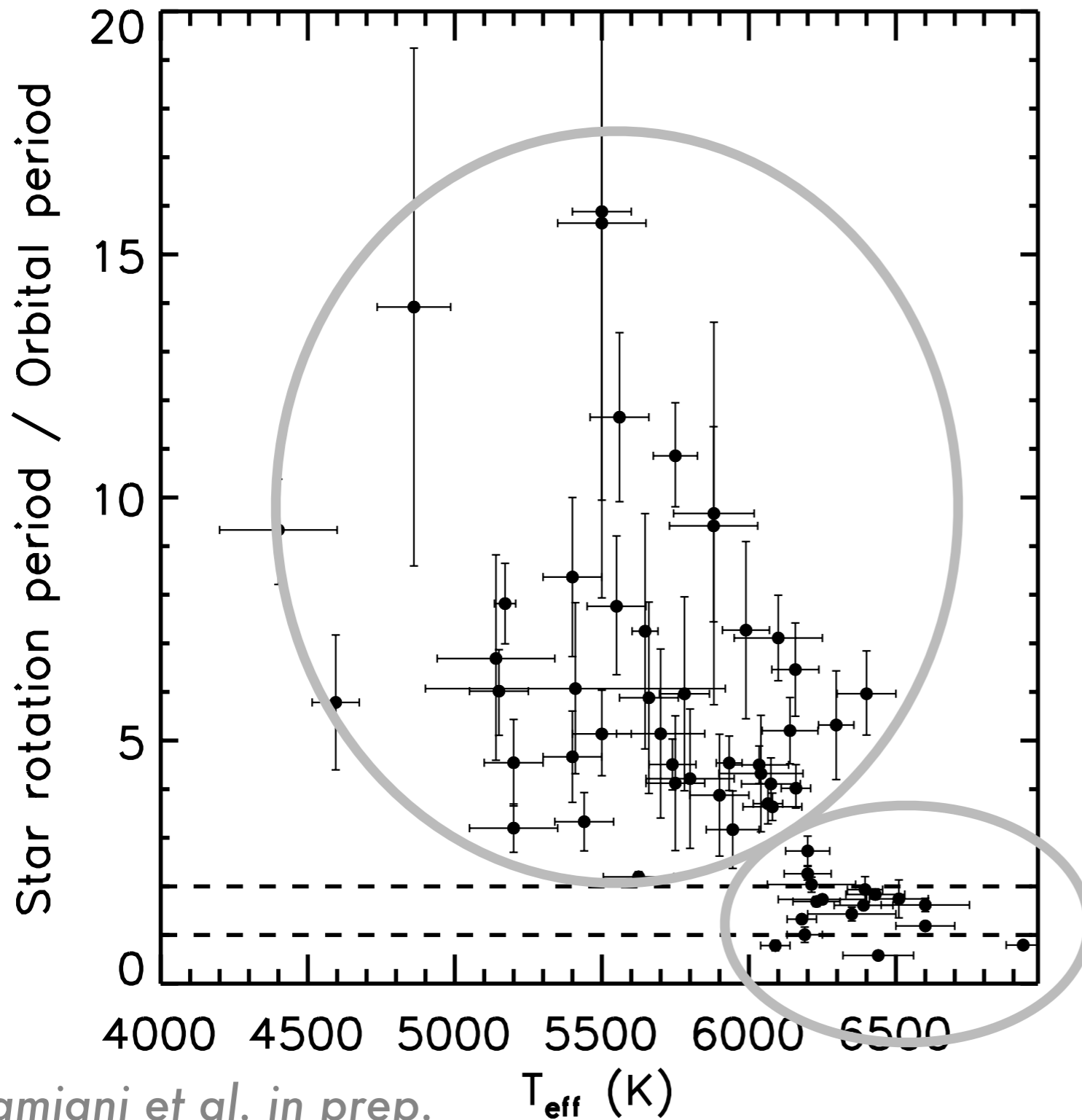NO equilibrium

Single circular aligned planets

Synchronisation

Single circular aligned planets

Damiani et al. in prep.
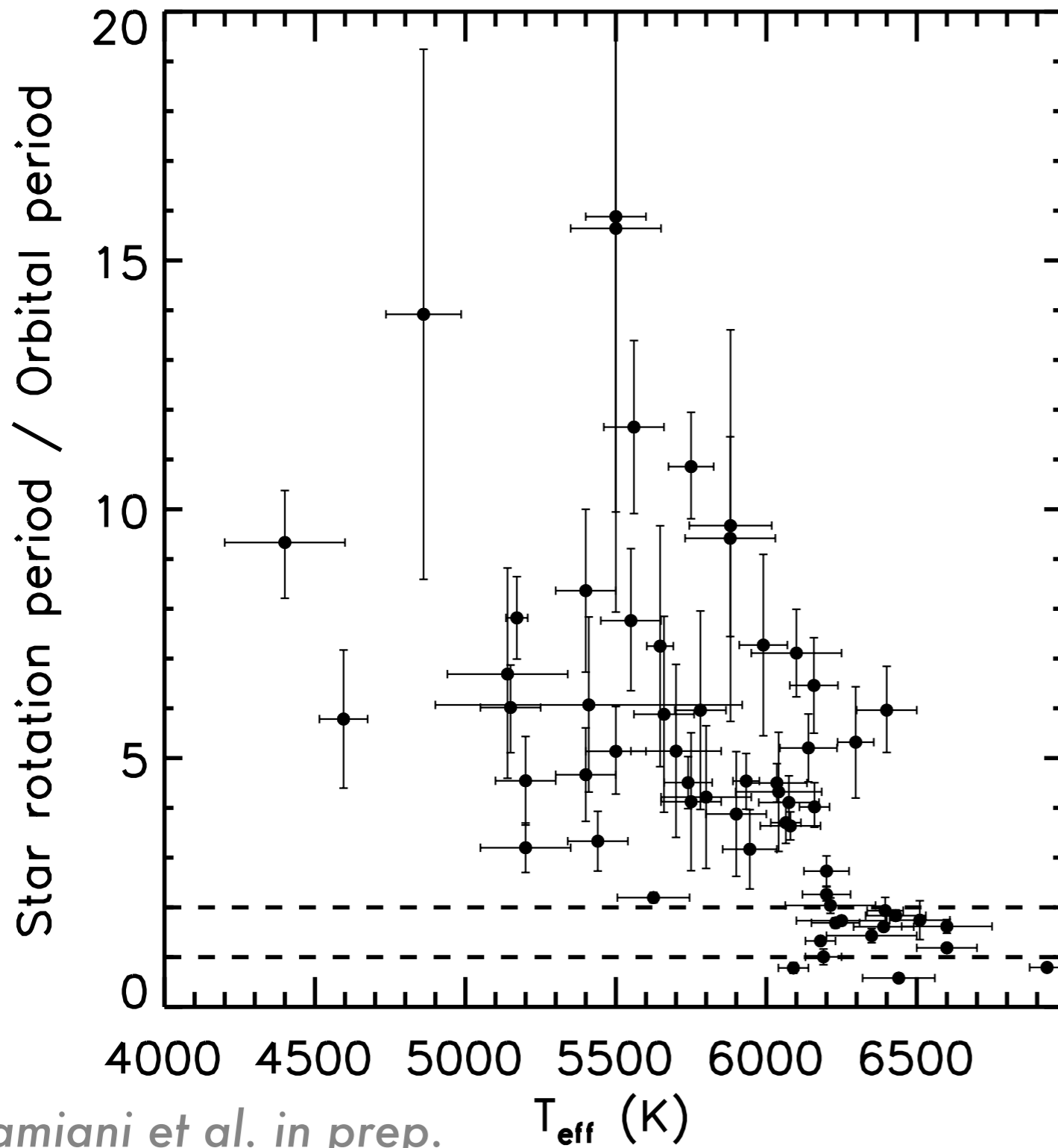
Synchronisation

Single circular aligned planets

Different tidal friction

and/or

Different angular
momentum loss

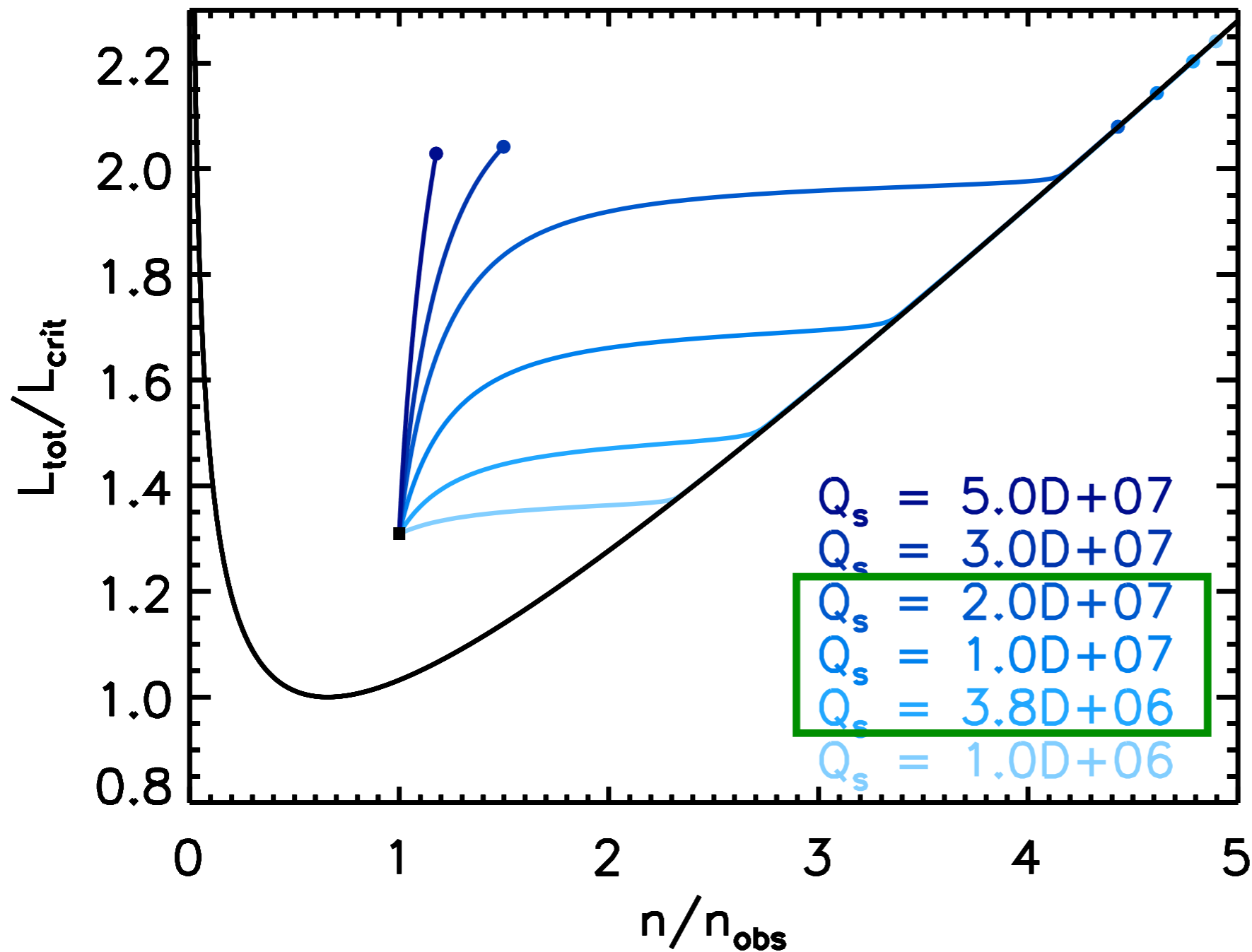*Damiani et al. in prep.*

Synchronisation

Single circular aligned planets

CoRoT-11

CoRoT-11

Evolution of the eccentricity

KOI-889b: Age = 6 ± 3 Gyr

$\tau_e \approx 100$ Myr

Today

Hébrard et al. 2013
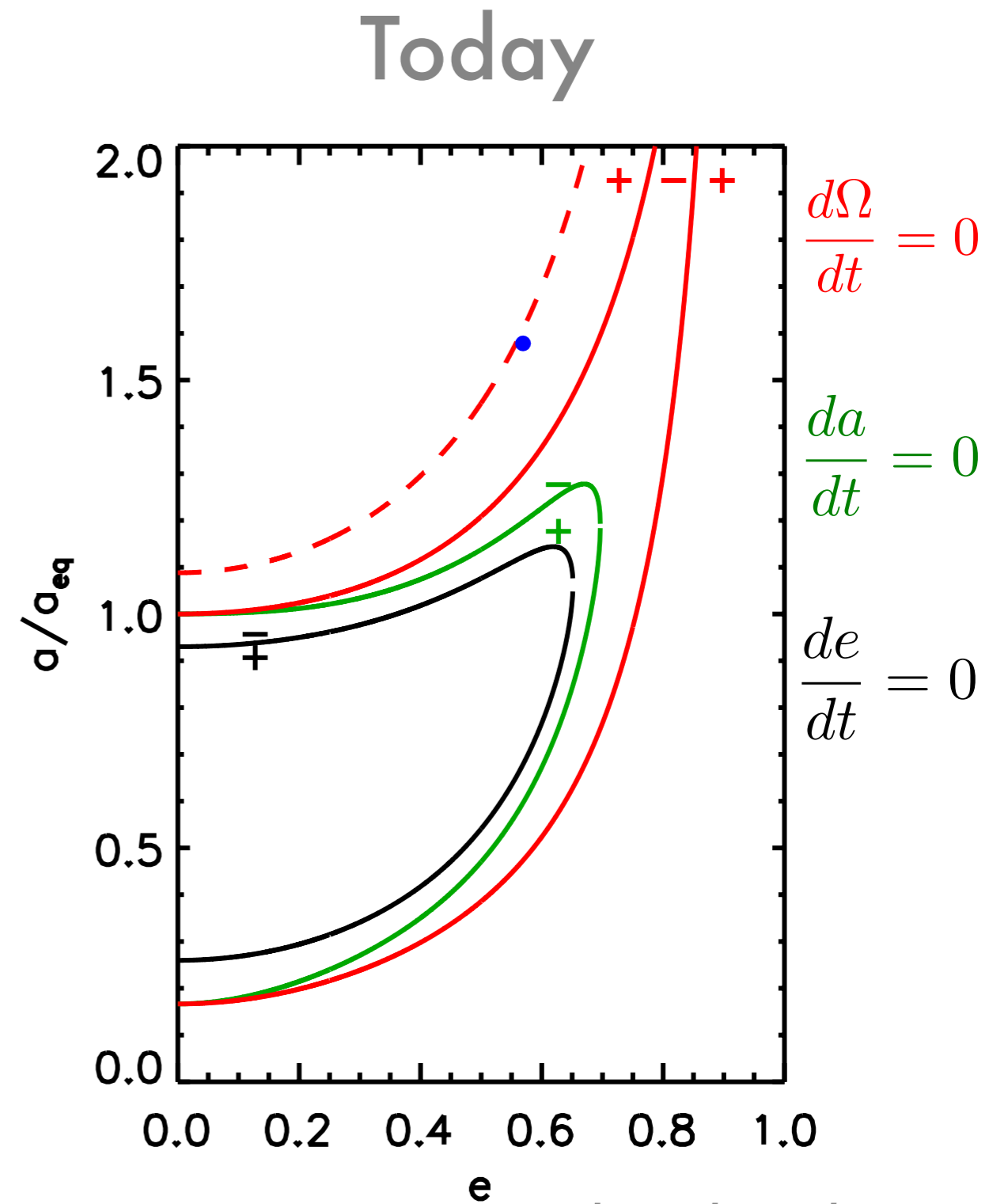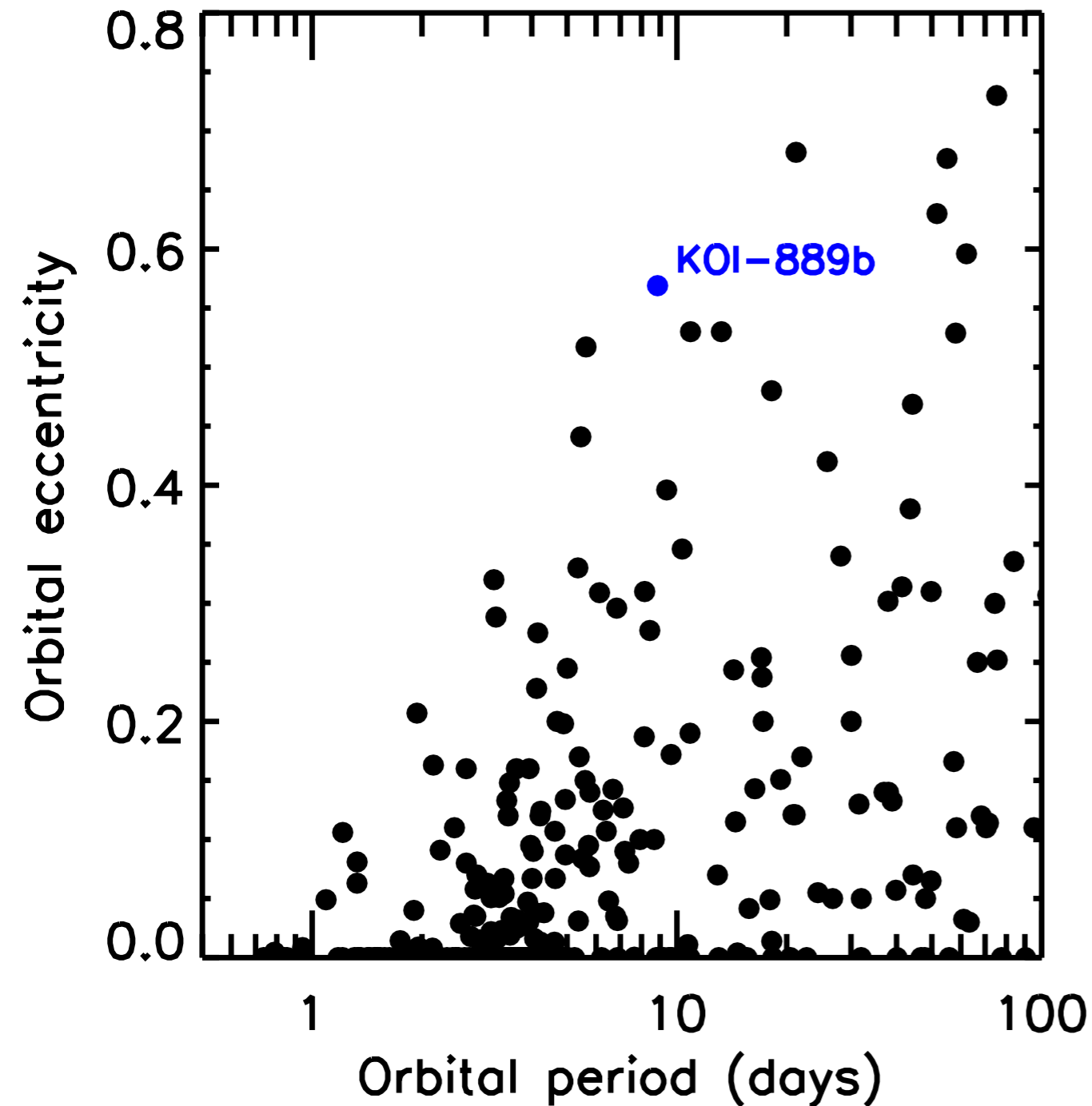
Evolution of the eccentricity
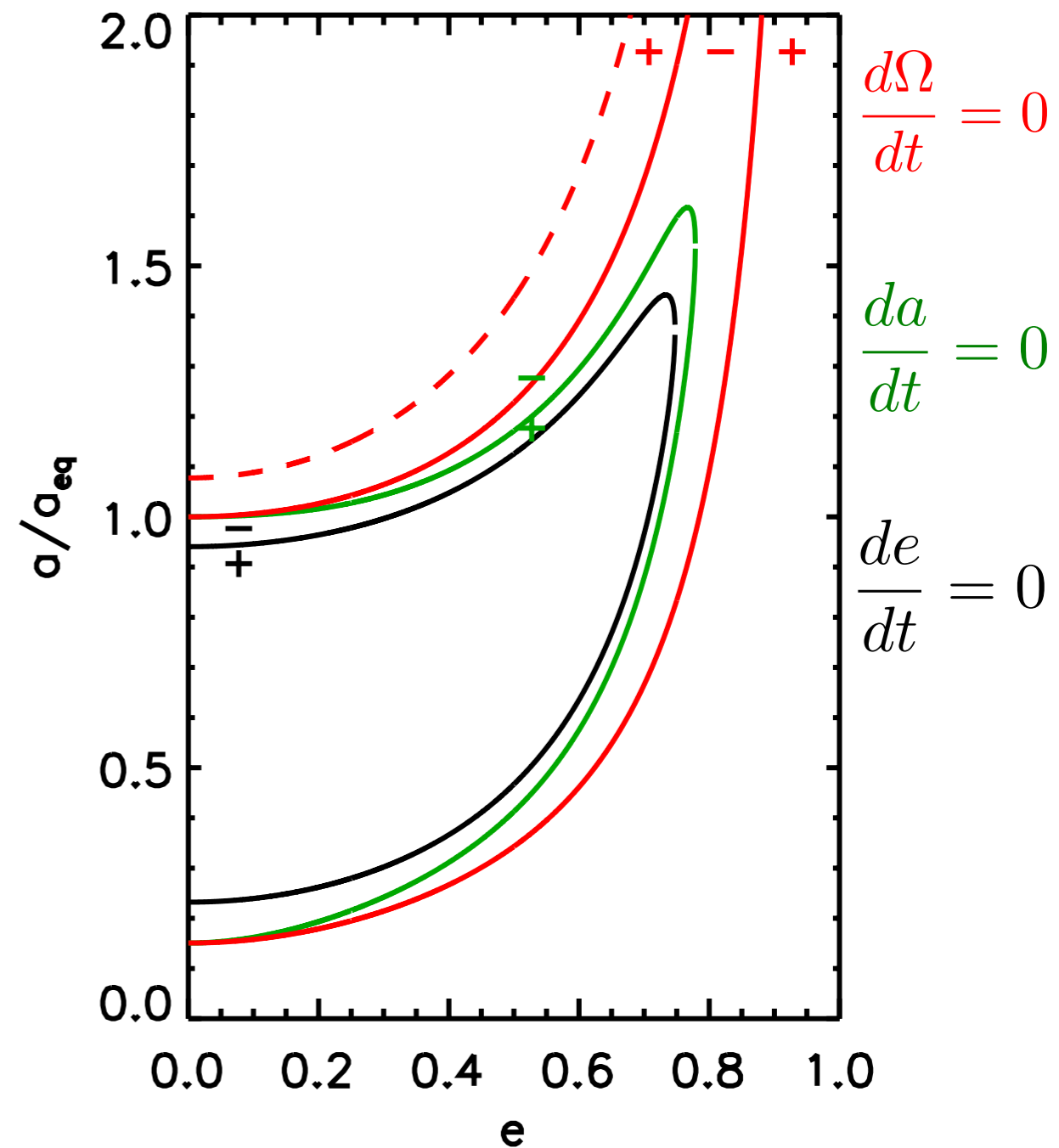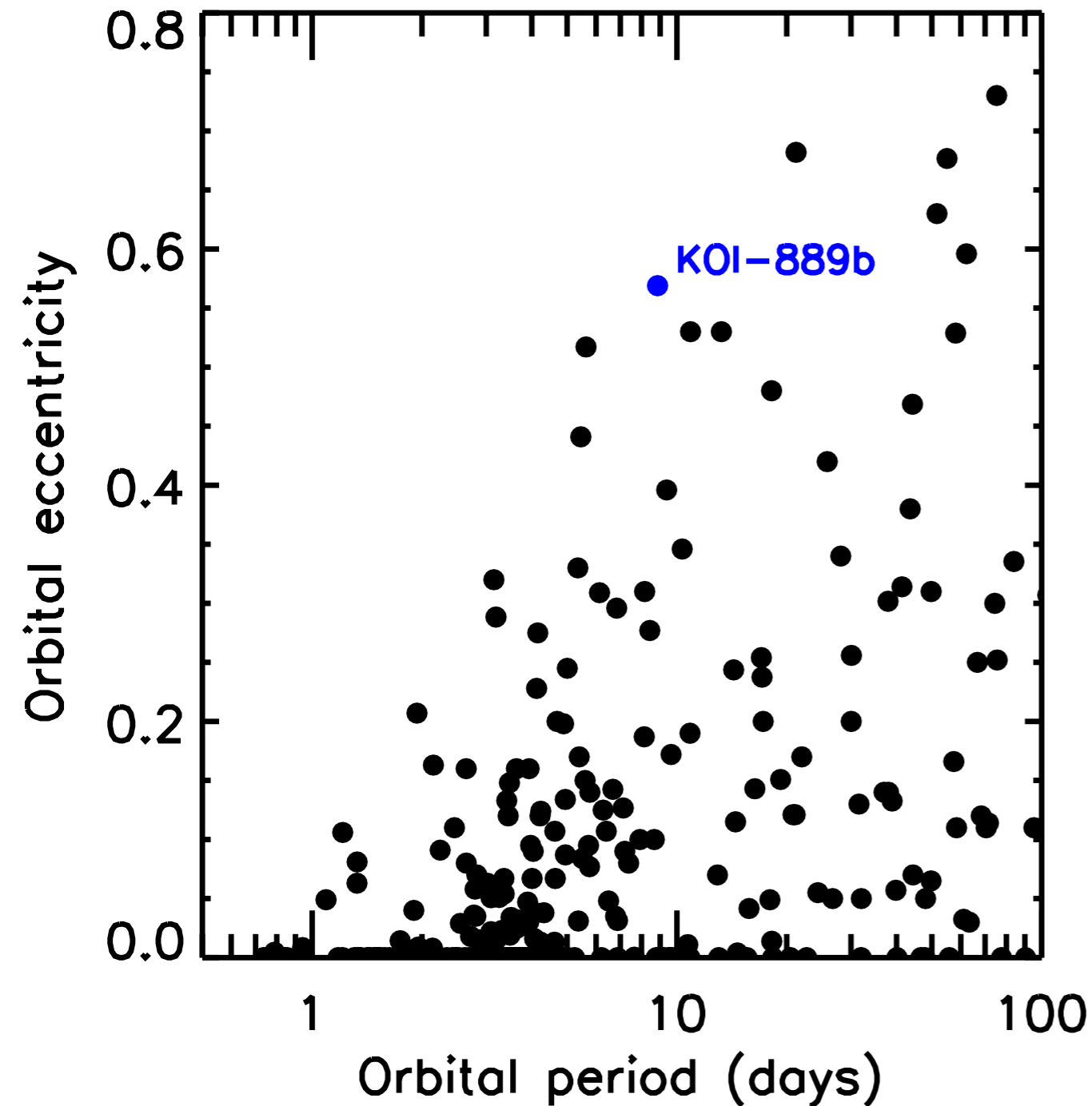
KOI-889b: Age = 6 ± 3 Gyr

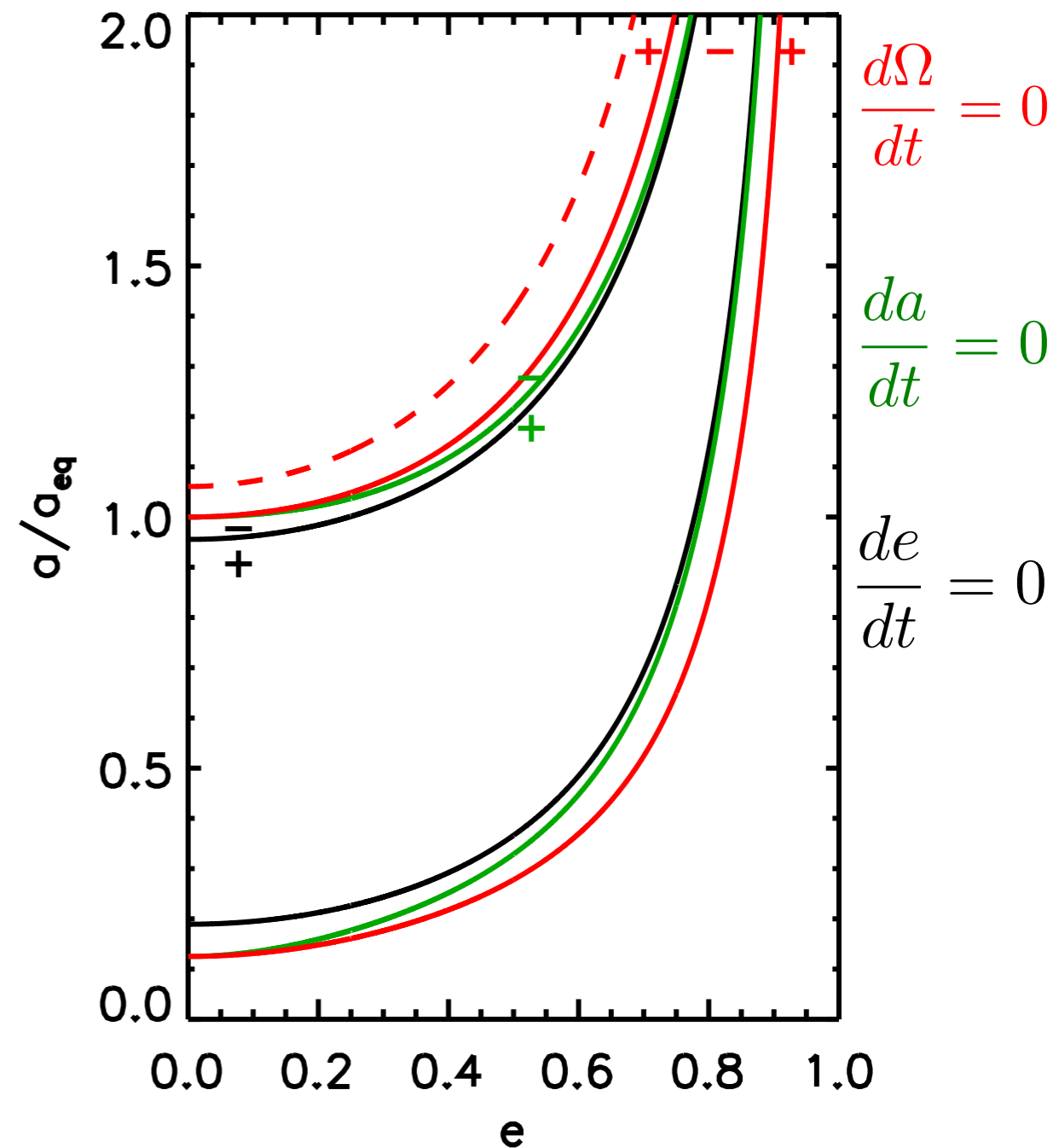$\tau_e \approx 100$ Myr
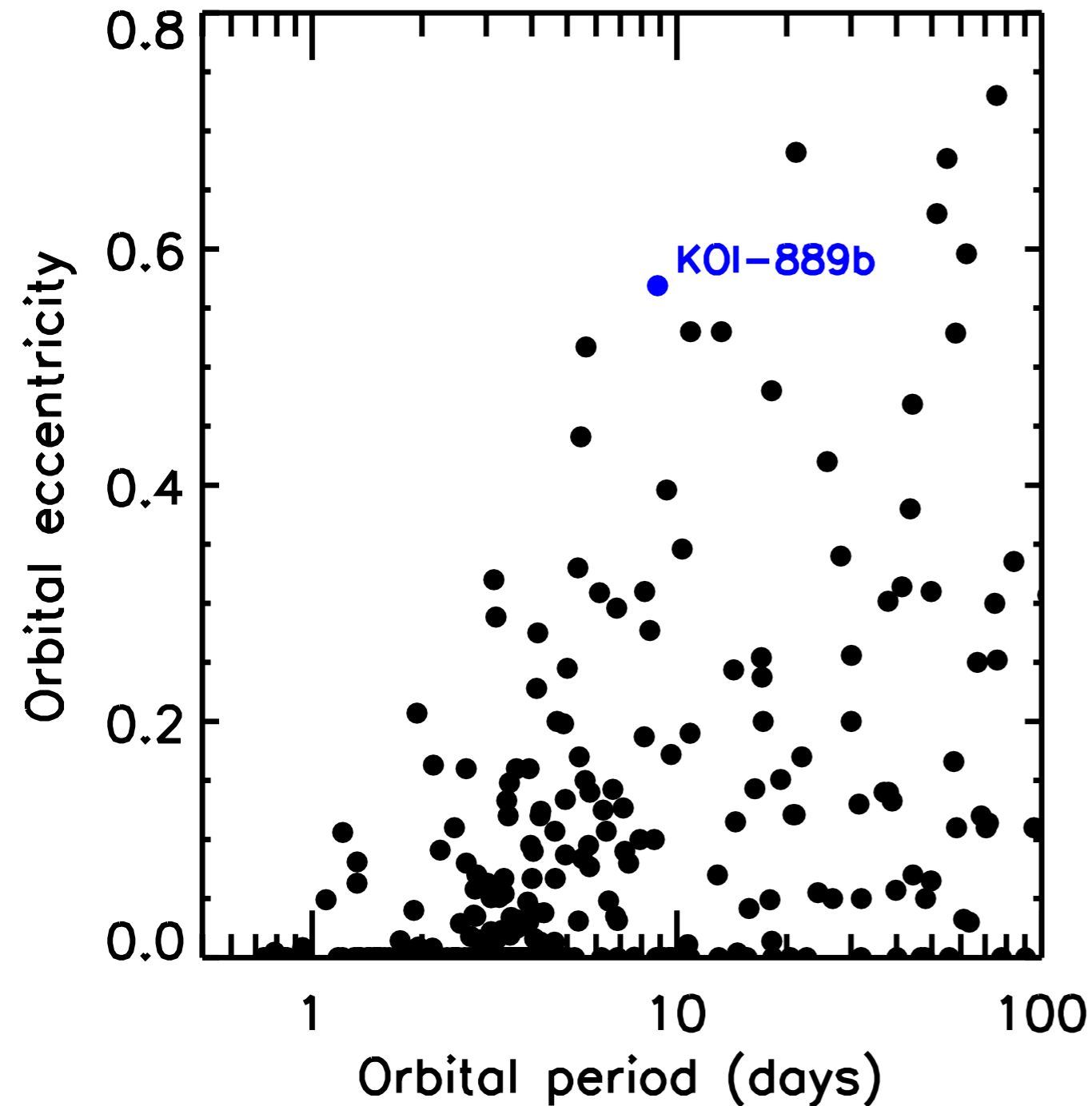
2.2 Gyr ago

Evolution of the eccentricity

KOI-889b: Age $= 6 \pm 3$ Gyr

$\tau_e \approx 100$ Myr

2.3 Gyr ago

More open questions

- Obliquity/Teff correlation?

- Obliquity and eccentricities are primordial?

- Initial angular momentum of the system?

- Hydromagnetic effects on the corona?

- For active stars, evaporation of the planet?

Why do we need PLATO?

Asteroseismology & photometry:

- Accurate stellar masses and radii
- Accurate ages
- Rotation period of the envelope (and the core)
- TTVs, TDVs, …
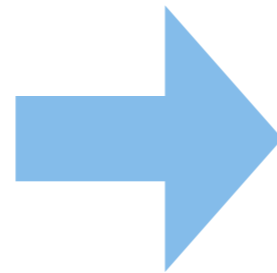
To test:

- Tidal dissipation
- Magnetic braking
- Formation theories