INAF

ISTITUTO NAZIONALE DI ASTROFISICA
OSSERVATORIO ASTROFISICO DI TORINO

Cold Jupiters and short-period small planets: Friends, foes, or indifferent?

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Bonomo et al. (2025), A&A, 700, A126

51 Peg b - Cool giant planets and their systems
Observatoire de Haute Provence (6-10 October, 2025)

Cold Jupiters (CJs) and small planets (SPs) are friends?

f_{CJ}: frequency of CJs around solar-type stars, regardless of the presence/absence of SPs

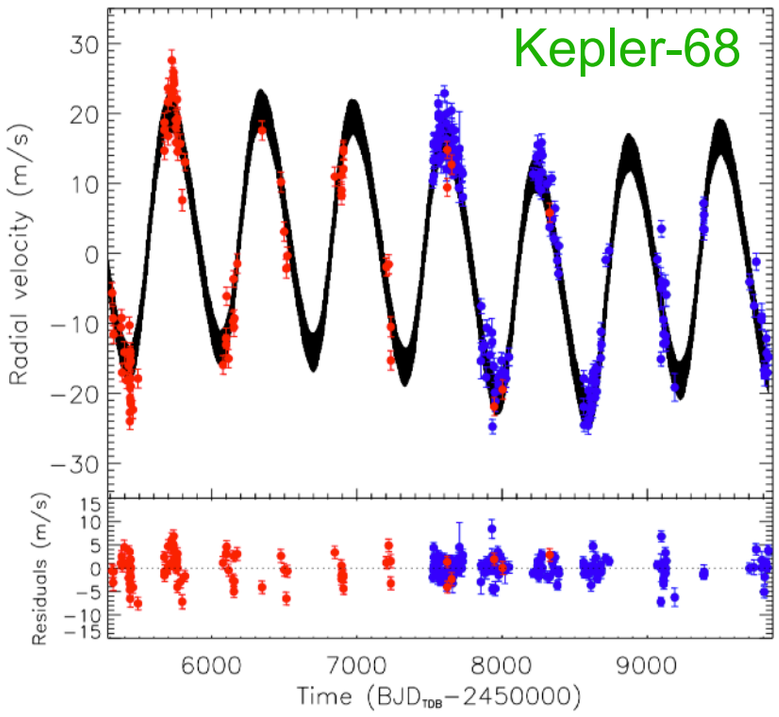
$f_{CJ|SP}$: frequency of CJs around solar-type stars with SPs (inside-out approach)

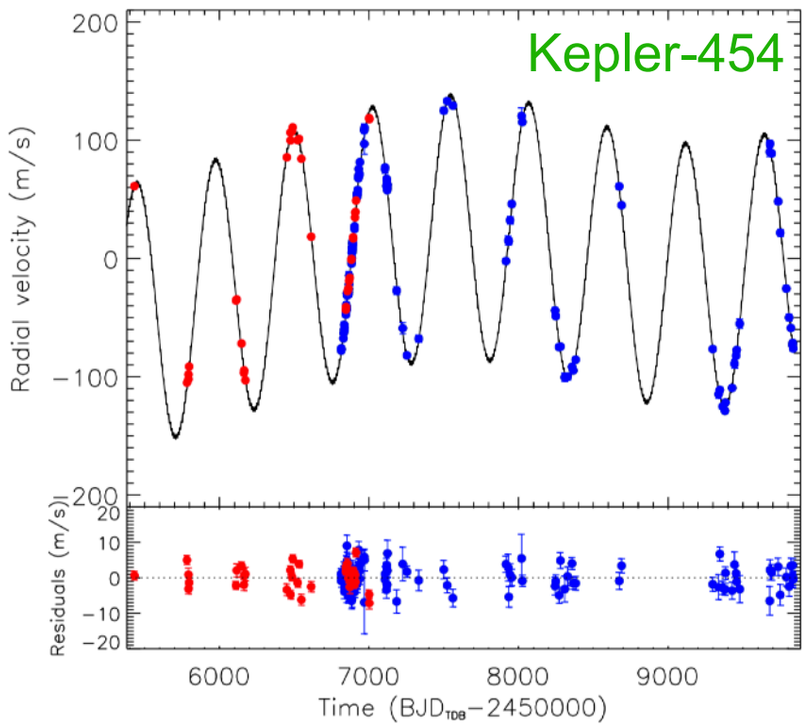
Yes: $f_{CJ|SP}$ = 38 ± 7 % ⇨ excess of CJs in SP systems (Bryan+2019; Zhu & Wu 2018)

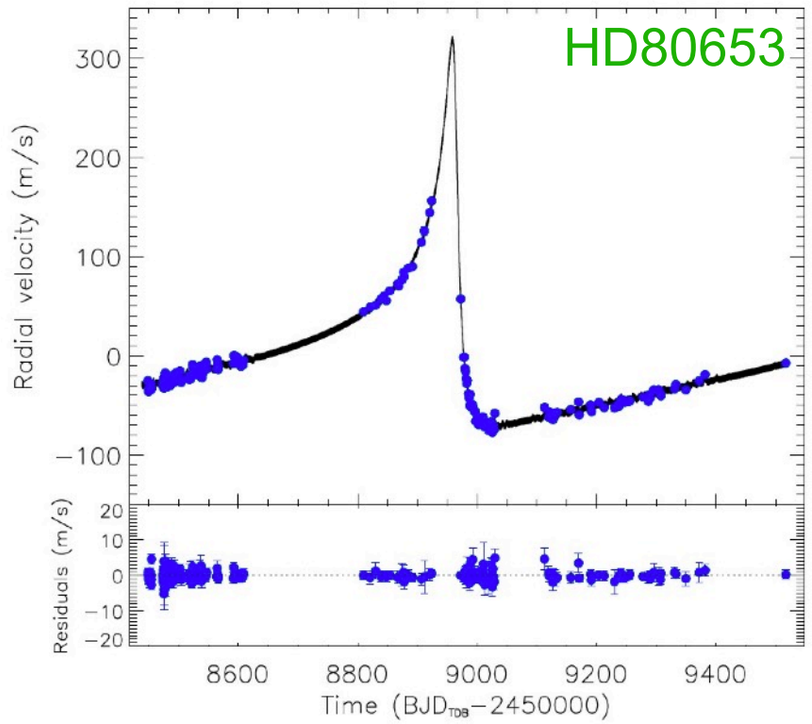
Maybe: $f_{CJ|SP}$ = 29 (-11 + 14) % ⇨ possible excess of CJs in SP systems (Rosenthal+2022; Van Zandt+2025)

No: $f_{CJ|SP}$ = 9 (+7 -3) % no excess of CJs in SP systems (Bonomo+2023) from the HARPS-N survey of 38 Kepler and K2 SP systems: 3 instead of 12±2 SP systems with CJs

SP systems with CJs found by the HARPS-N Collaboration

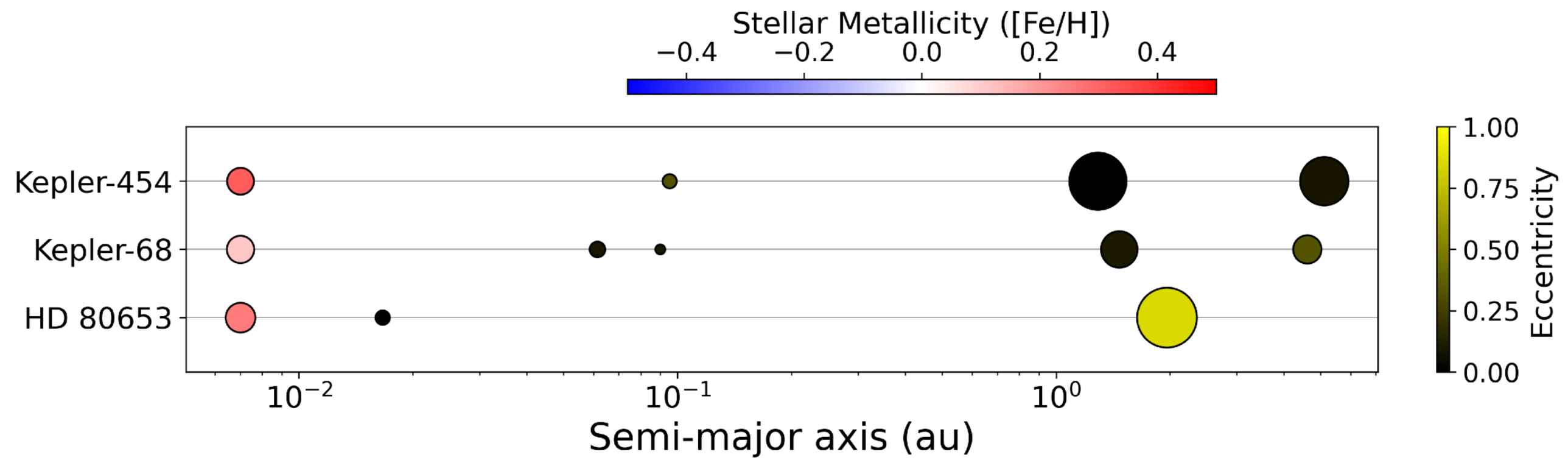




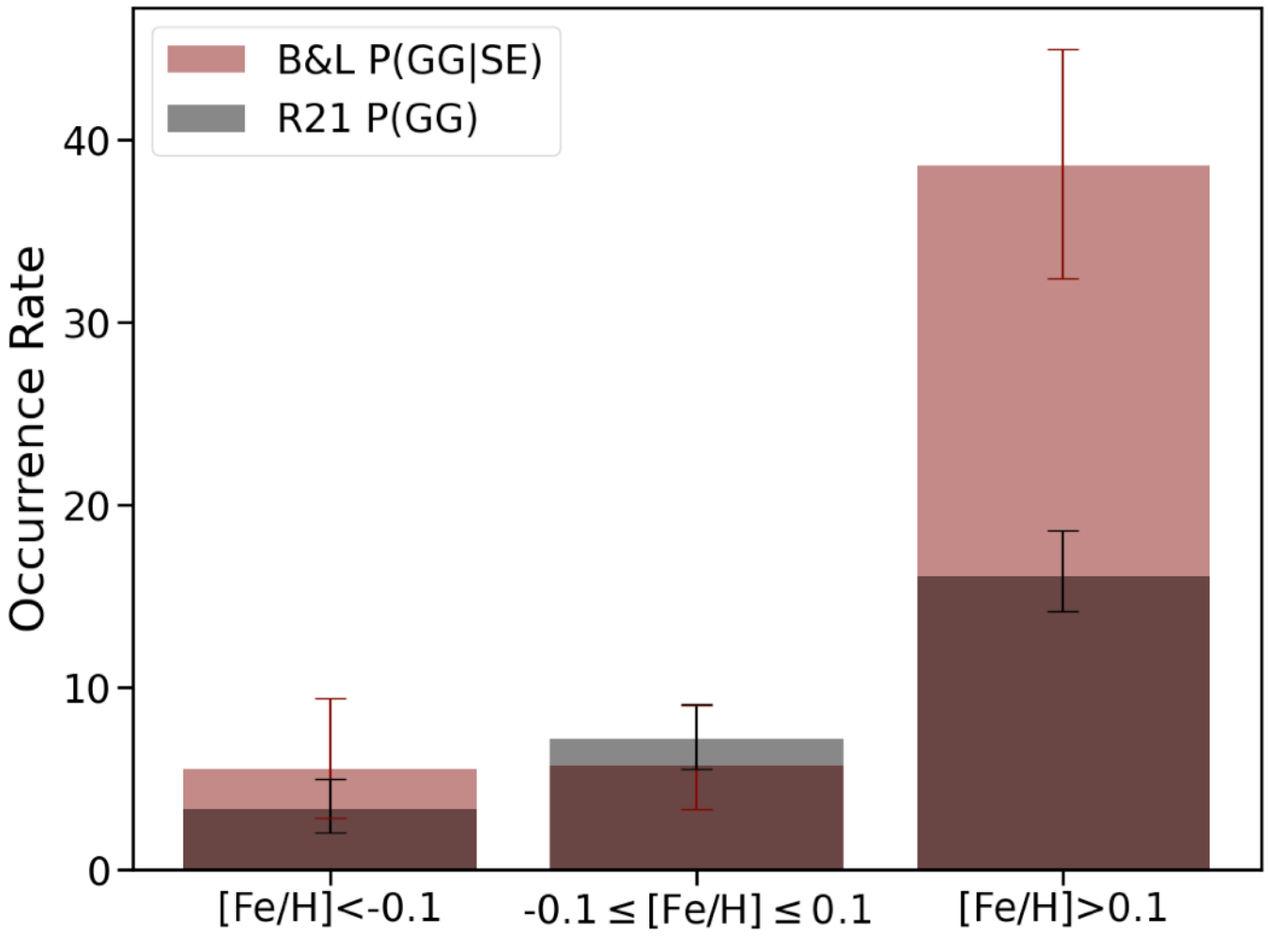


Blue circles: HARPS-N@TNG data
Red circles: HIRES@Keck data (Weiss+2024)

(Bonomo, Dumusque, Massa et al. 2023)



CJs and SPs are friends only at [Fe/H] > 0.1?



(Bryan & Lee 2024)

By averaging over all metallicities

$f_{CJ|SP}$ = 15 (+3 -2) %

Bryan & Lee 2024 (<Fe/H> = -0.001 dex)

vs

$f_{CJ|SP}$ = 9 (+7 -3) %

Bonomo+2023 (<Fe/H> = -0.065 dex)

- SP sample (including “mixed systems”): **184 SP systems** (109 transit + 75 RV) with at least one SP with $1<R_p<4\ R_\oplus$; $1<M_p<20\ M_\oplus$, $n_{RV}>20$, $\Delta T>1$ yr, $M_\star>0.6\ M_\odot$

- **Comparison sample of 562 stars** from the CLS (California Legacy Survey, Rosenthal et al. 2021) RV survey

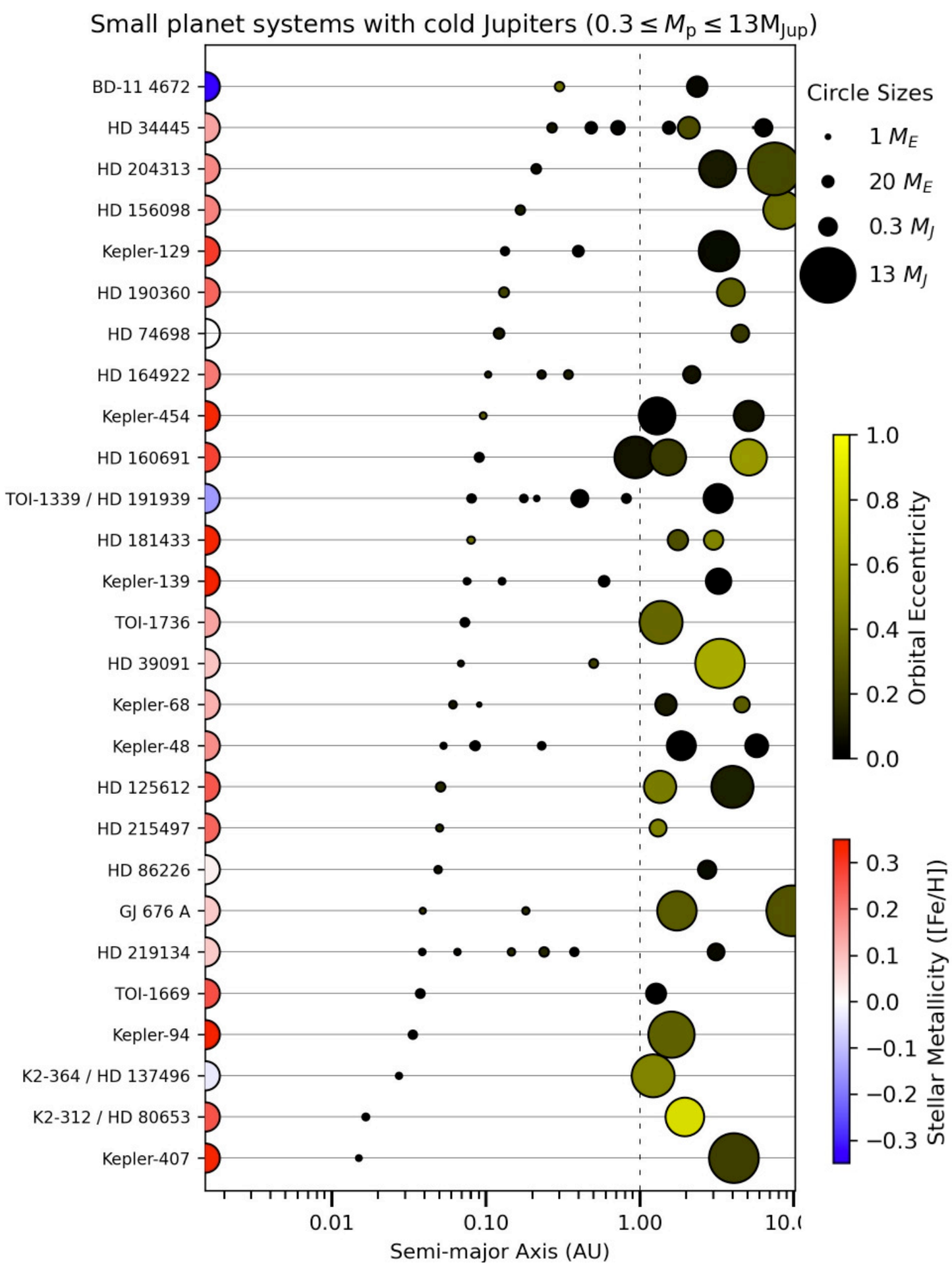
- Homogeneous completeness (detection sensitivity) from RV formal uncertainties (no jitter)

Our samples

- SP sample (with and without “mixed systems”): **217 SP systems** (134 transit + 83 RV) with at least one SP with $1<M_p<20\ M_\oplus$, $n_{RV}>20$, $\Delta T>1$ yr, $M_\star>0.6\ M_\odot$

- **Comparison sample of 1167 stars** from the HARPS, CLS, and AAT surveys

- Homogeneous completeness (detection sensitivity) from RV formal uncertainties (no jitter)



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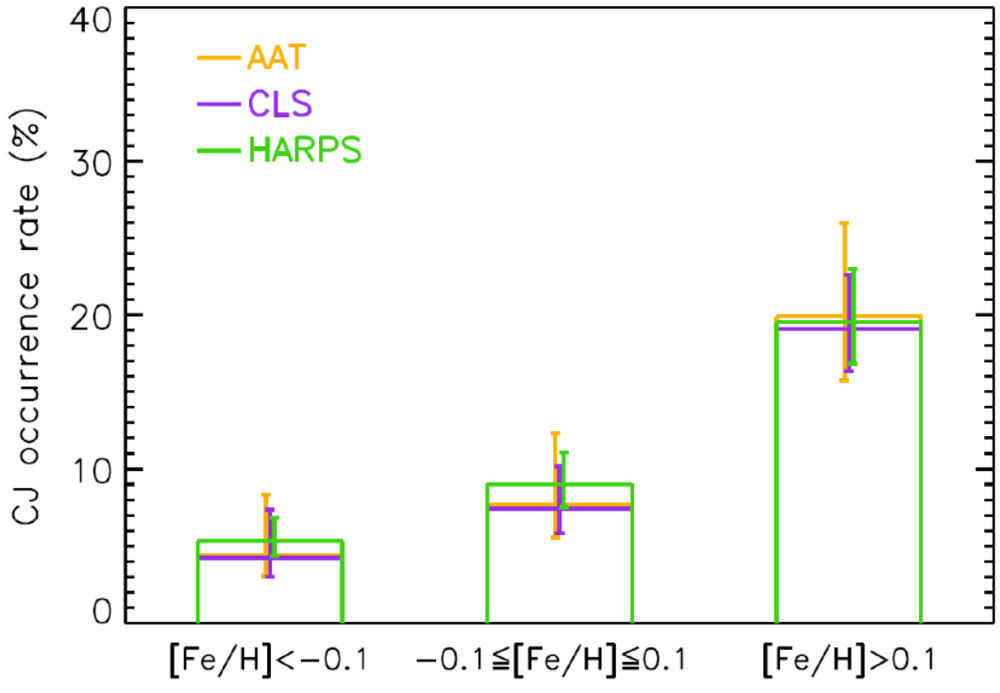
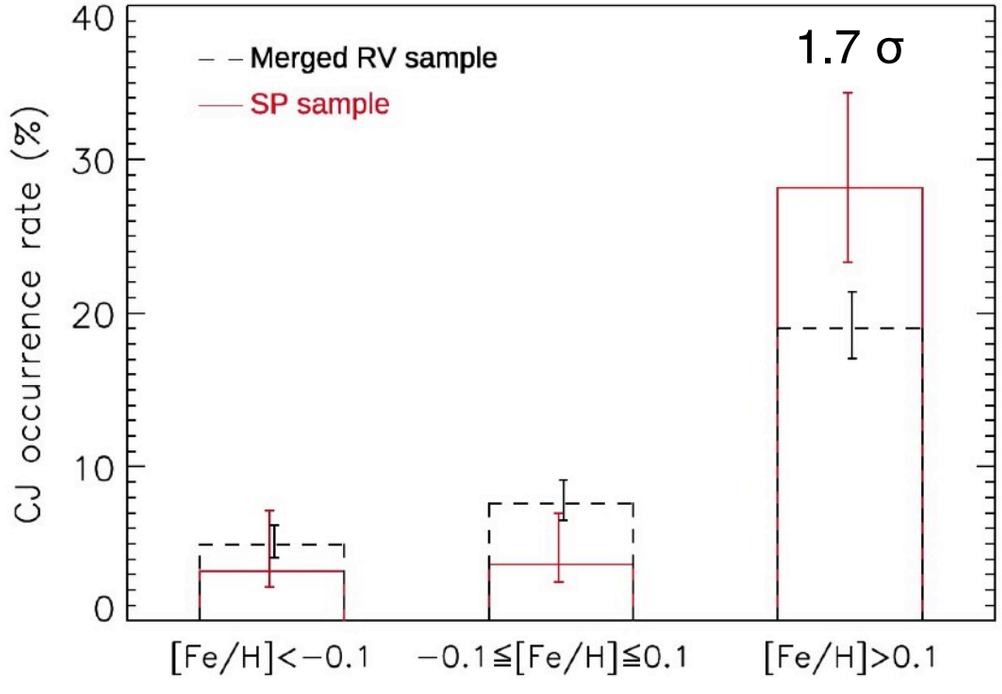
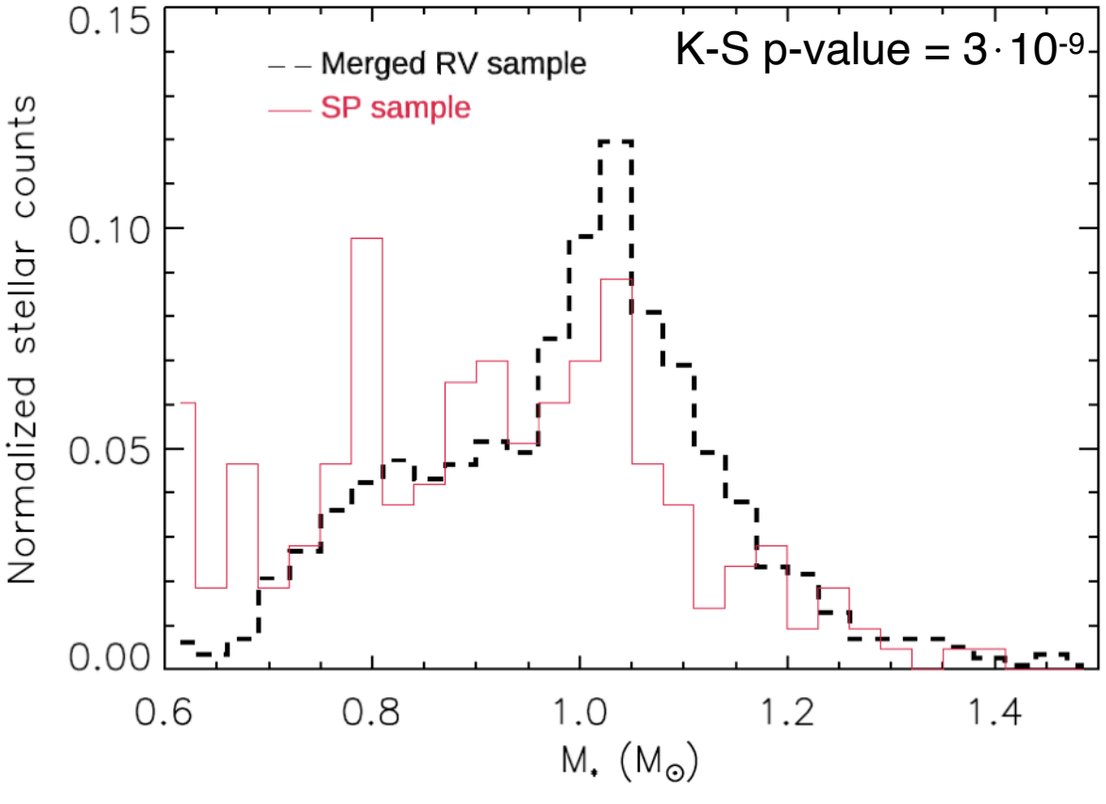
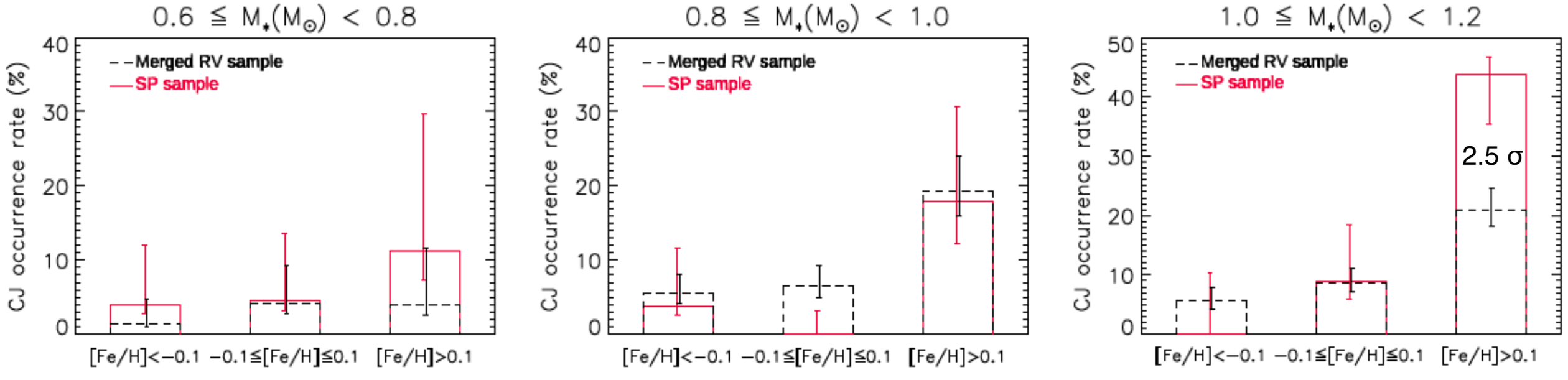






Bias on the $M_\star$ distribution of the SP sample due to the RV and/or transit selection effects.

CJs and SPs are friends only at [Fe/H] > 0.1 and M≧1 $M_\odot$?



$f_{CJ|SP}$ = 11.1 (+2.5 -1.8) % vs f_{CJ} = 9.8 (+0.9 -0.8) %

Consistent results on the dependence of $f_{CJ|SP}$ on [Fe/H] and $M_\star$ were independently found by Bryan & Lee 2025.

N.B.: $f_{CJ|SP}$ and f_{CJ} may slightly change if long-term RV trends turn out to be CJs and/or $M_p \sin i$ of CJs from Gaia astrometry turn out to be $M_p > 13$ or 20 M_{Jup}. Moreover, they must be updated as more and more well-characterized systems are available.

CJs and SPs are friends or foes?

- Anticorrelation: CJs as dynamical barriers to sub-Neptune inward migration (e.g., Izidoro+2015) or hindrance to SP formation inside the water snowline (Lambrechts+2019)

- Weak or no correlation from planetesimal (Schleckler+2021) or pebble (Danti+2025) accretion

- Strong correlation for low efficient gas contraction rate (Bitsch & Izidoro 2023) or planetesimal snowplow-like process due to CJ-induced secular resonances (Best+2024, 2025).

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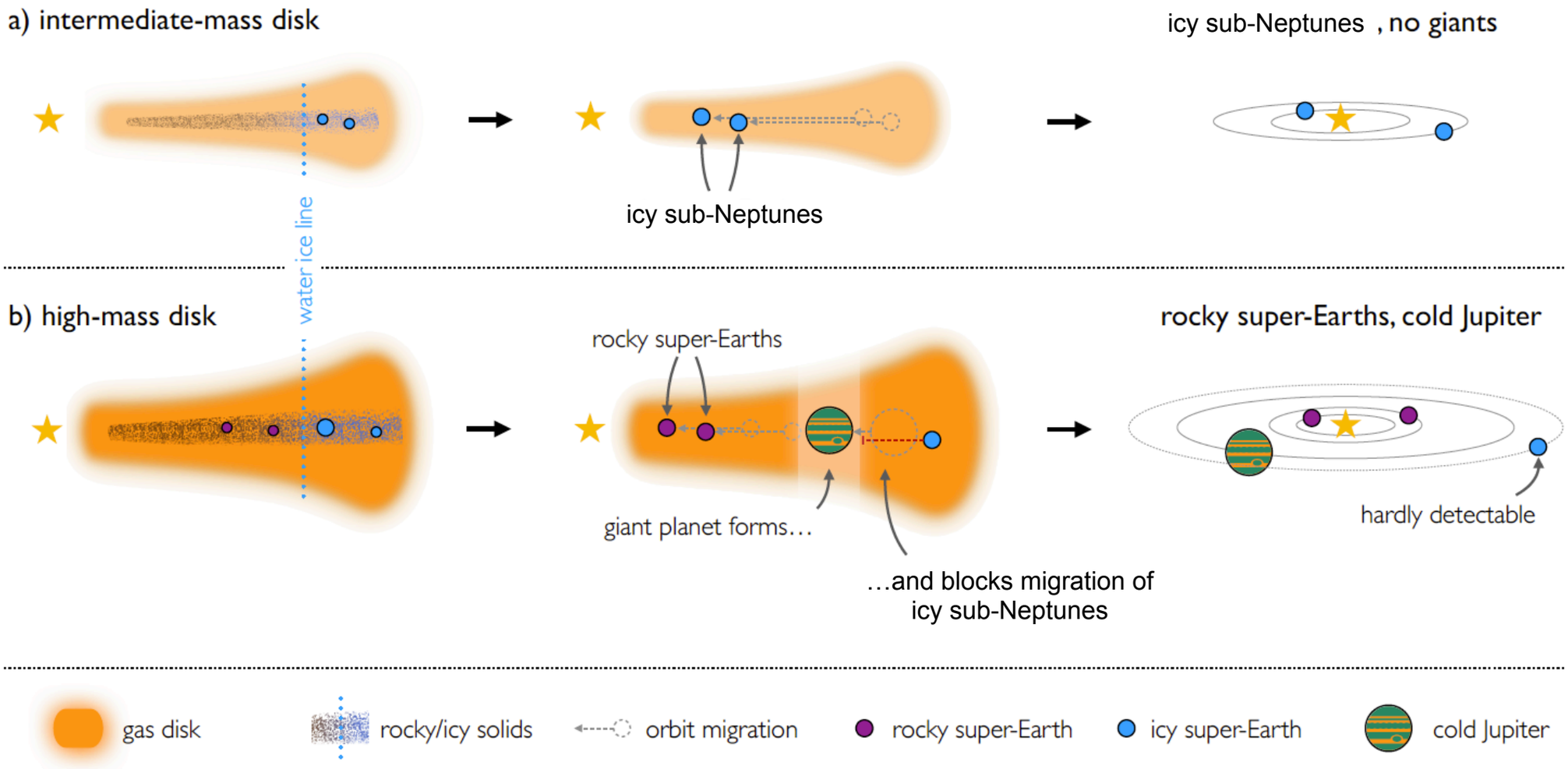
? at [Fe/H] > 0.1 and M≧1 $M_\odot$

Any strong architecture-composition link?

Generation 3 Bern Planet Population Synthesis
(Schlecker et al. 2021)



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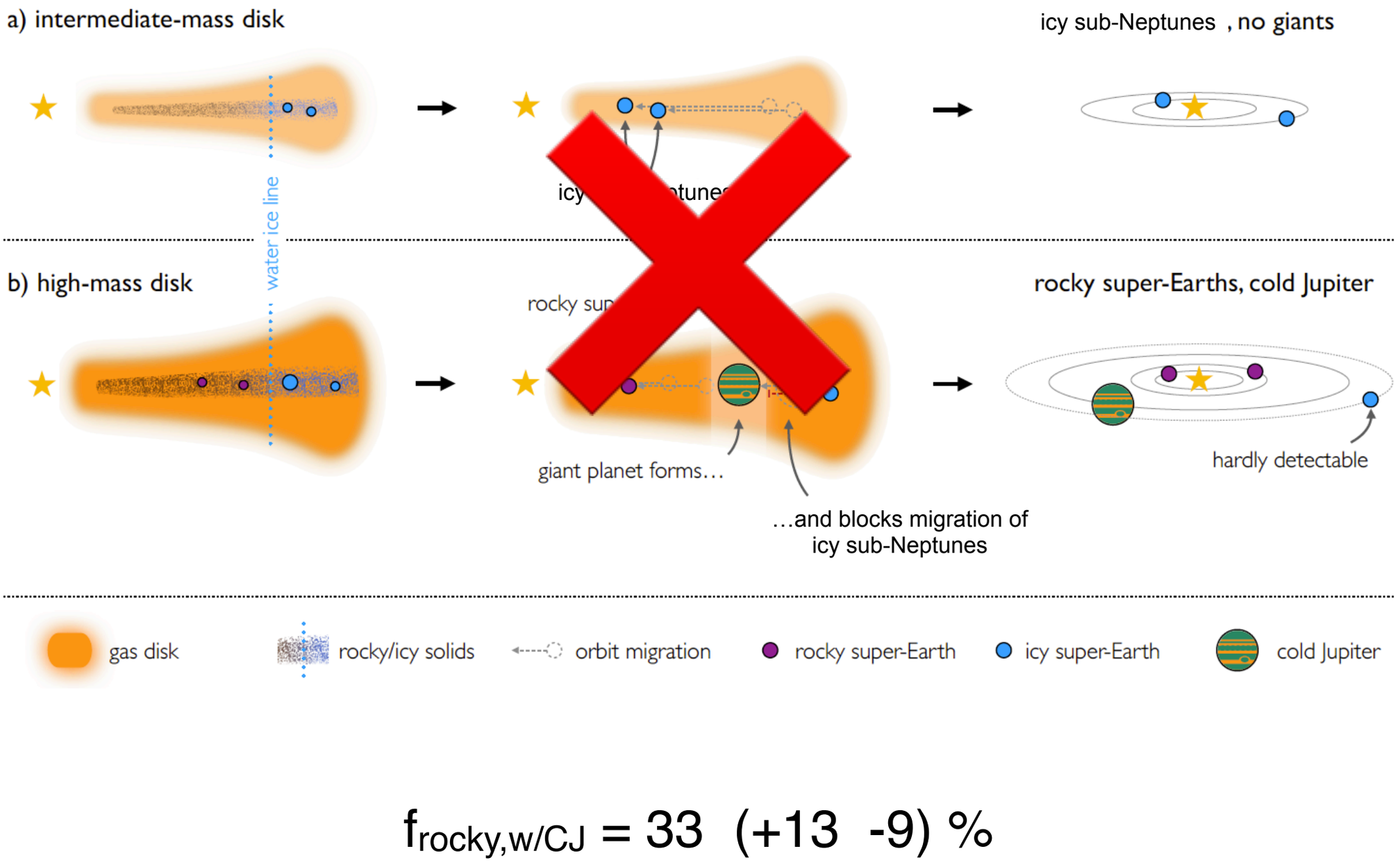

$$f_{rocky,w/CJ} = 33 \ (+13 \ -9) \ \%$$

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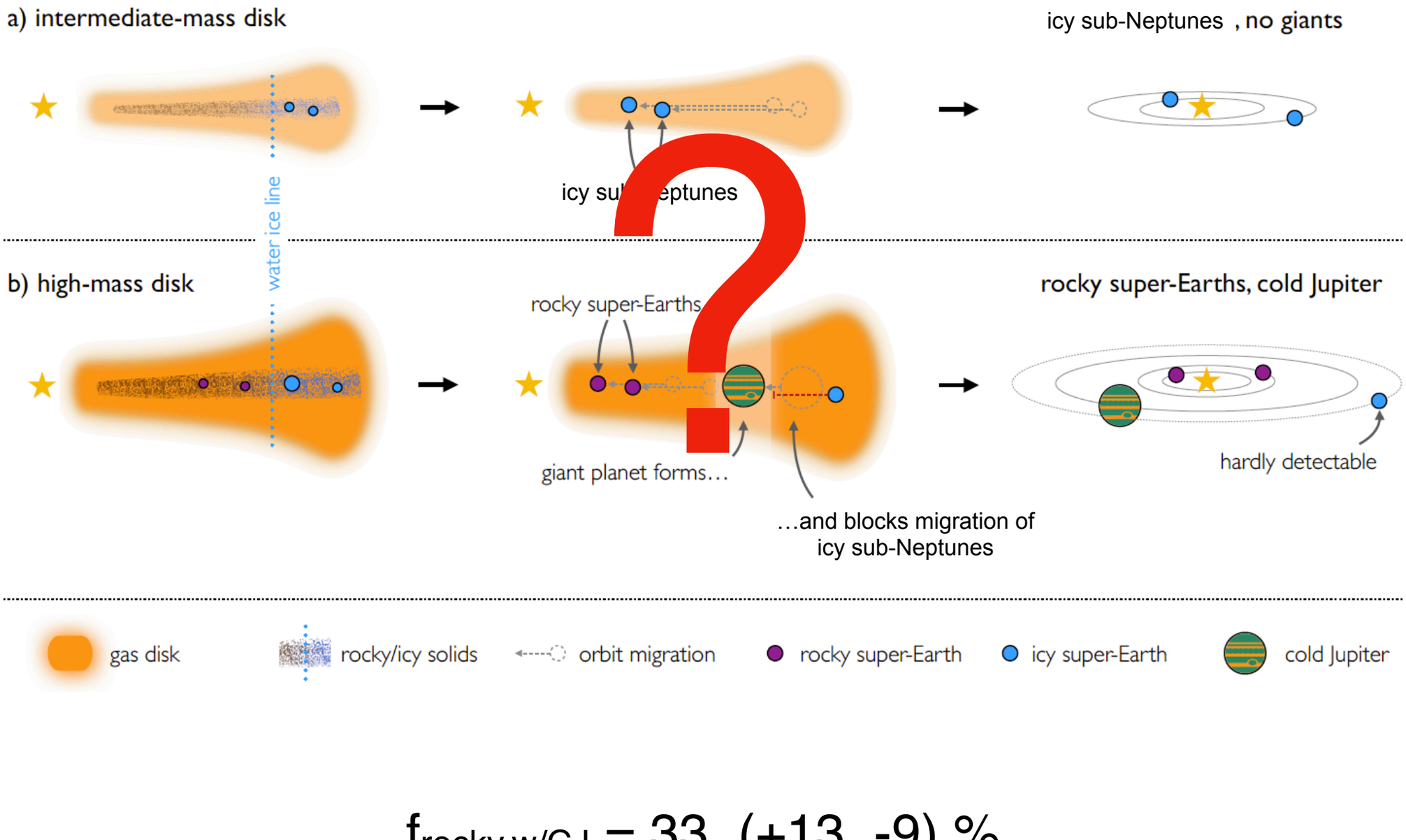

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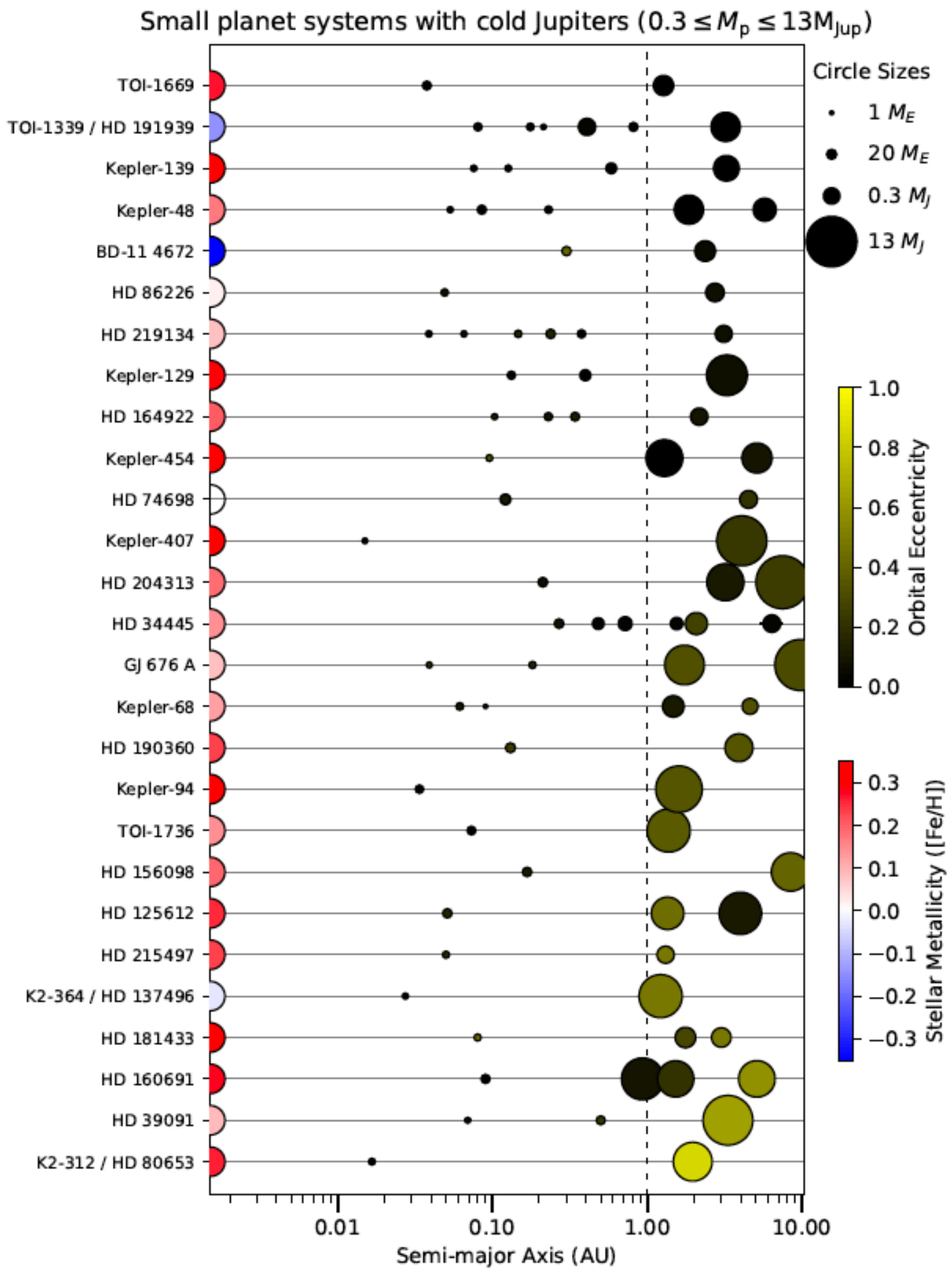

SP systems are NOT indifferent to CJs

The architecture of SP systems can be greatly influenced by CJs (e.g., dynamical instabilities in inner regions and/or SP inclination excitation)

On the shoulders of giants

Cold Jupiters and their role in the formation of inner low-mass planets. From theory to observations

25-26-27 March 2026

Turin

Information on registration and abstract submission will be soon available

Invited speakers: *Eleonora Alei, Bertram Bitsch, Timothy Brandt, Marta Bryan, Juan Cabrera, Gael Chauvin, Joao Faria, Jonathan Horner, Anne-Marie Lagrange, Gijs Mulders, Luca Naponiello, Matteo Pinamonti, Sean Raymond, Judah Van Zandt, Lauren Weiss.*