Exoplanet Populations beyond *Kepler*

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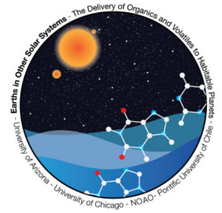
Collaborators: G. Mulders, R. Fernandes, D. Apai, F. Ciesla, A. Gould, C. Mordasini, A. Emsenhuber



Pascucci et al. 2018 (ApJ, 856L, 28): Kepler + microlensing occurrence rates

- Focus on sub-giant planets

Fernandes et al. 2018 (arXiv:1812.05569): Kepler + RV occurrence rates

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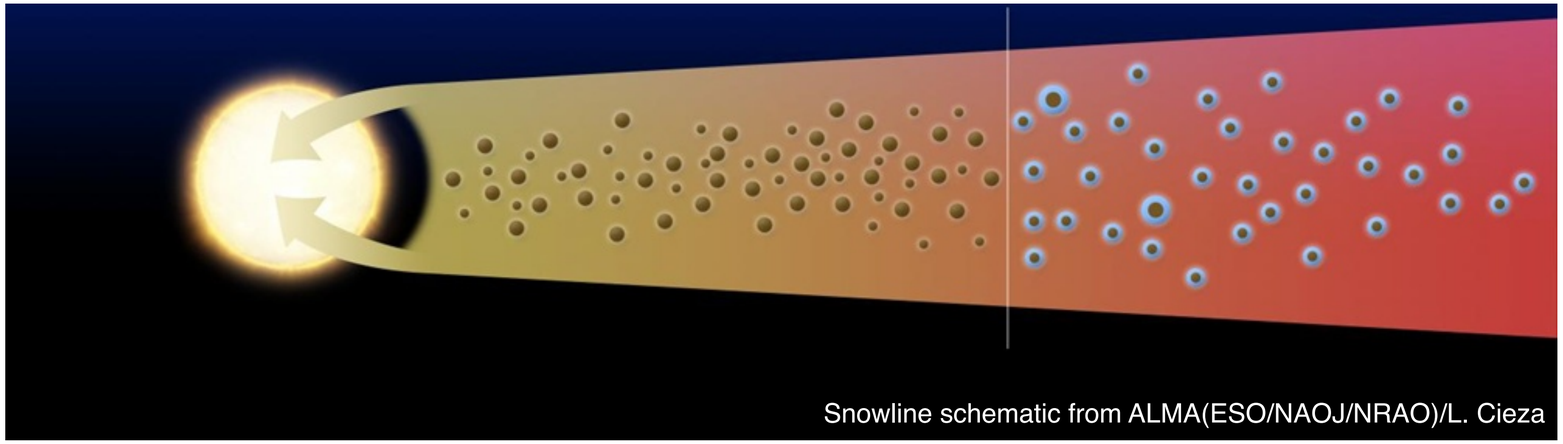

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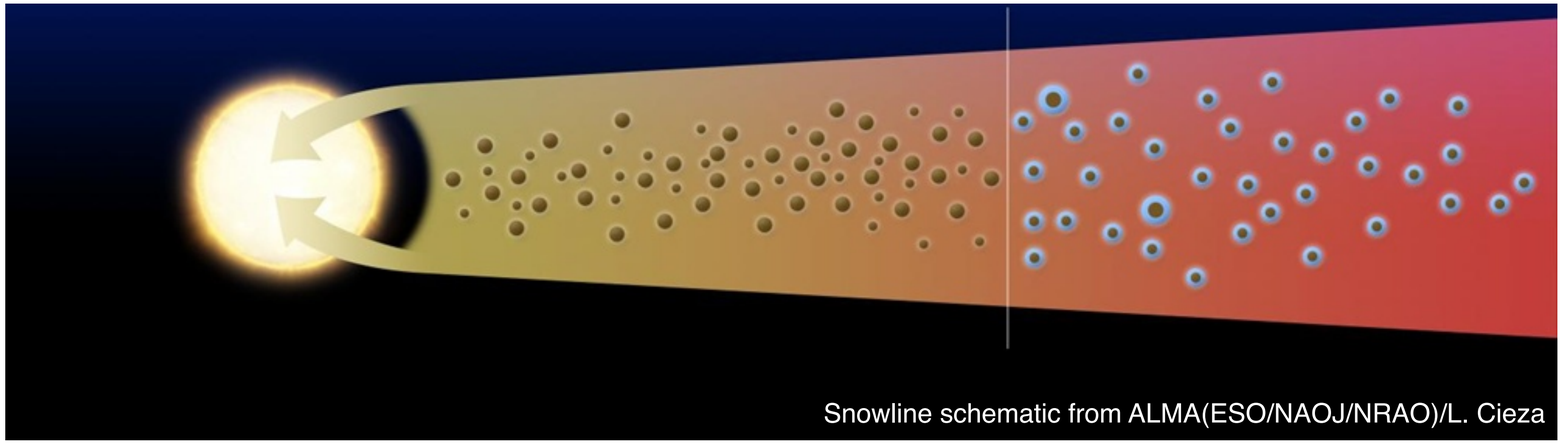
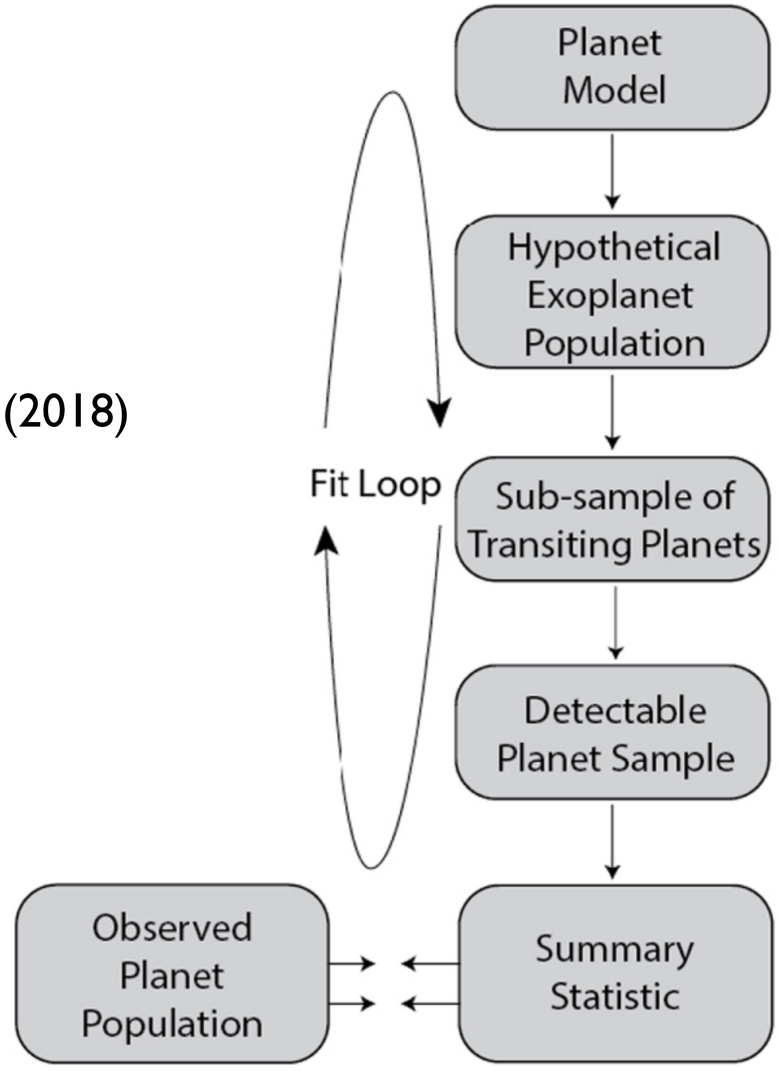


EPOS: Exoplanet Population Observation Simulator (Mulders et al. 2018): http://eos-nexus.org/epos/

EPOS High-level Flowchart

Logical Steps



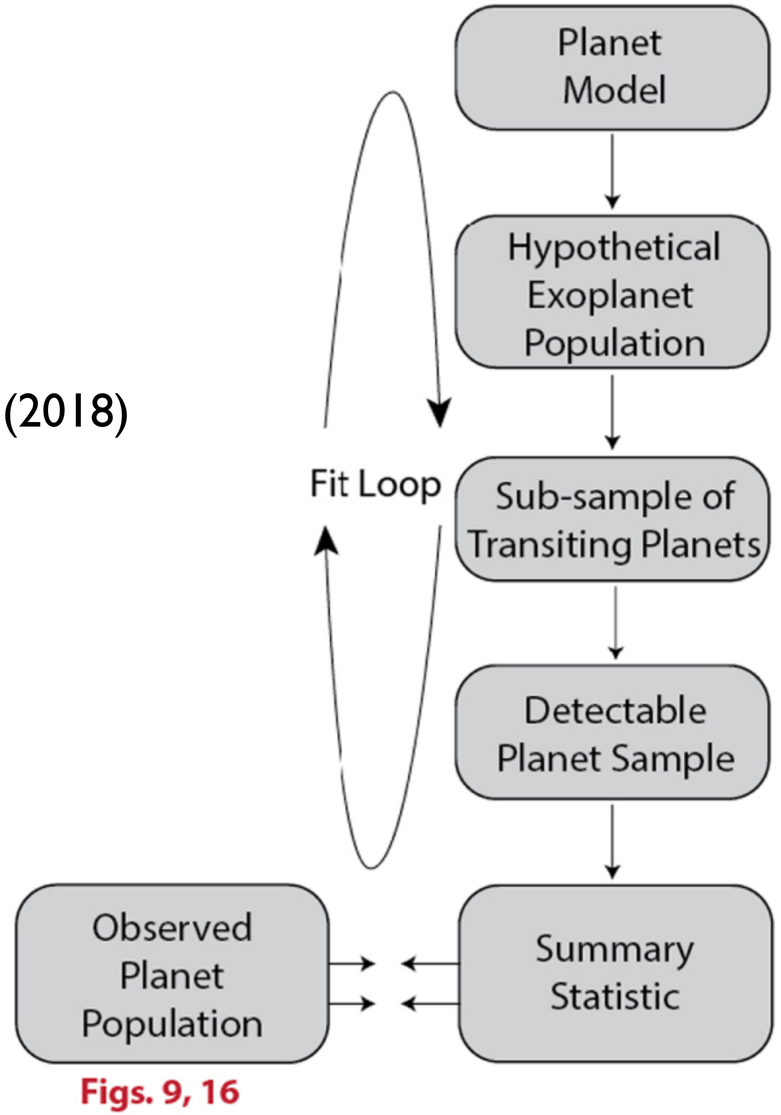
Figs. 9, 16

Mulders et al. (2018)

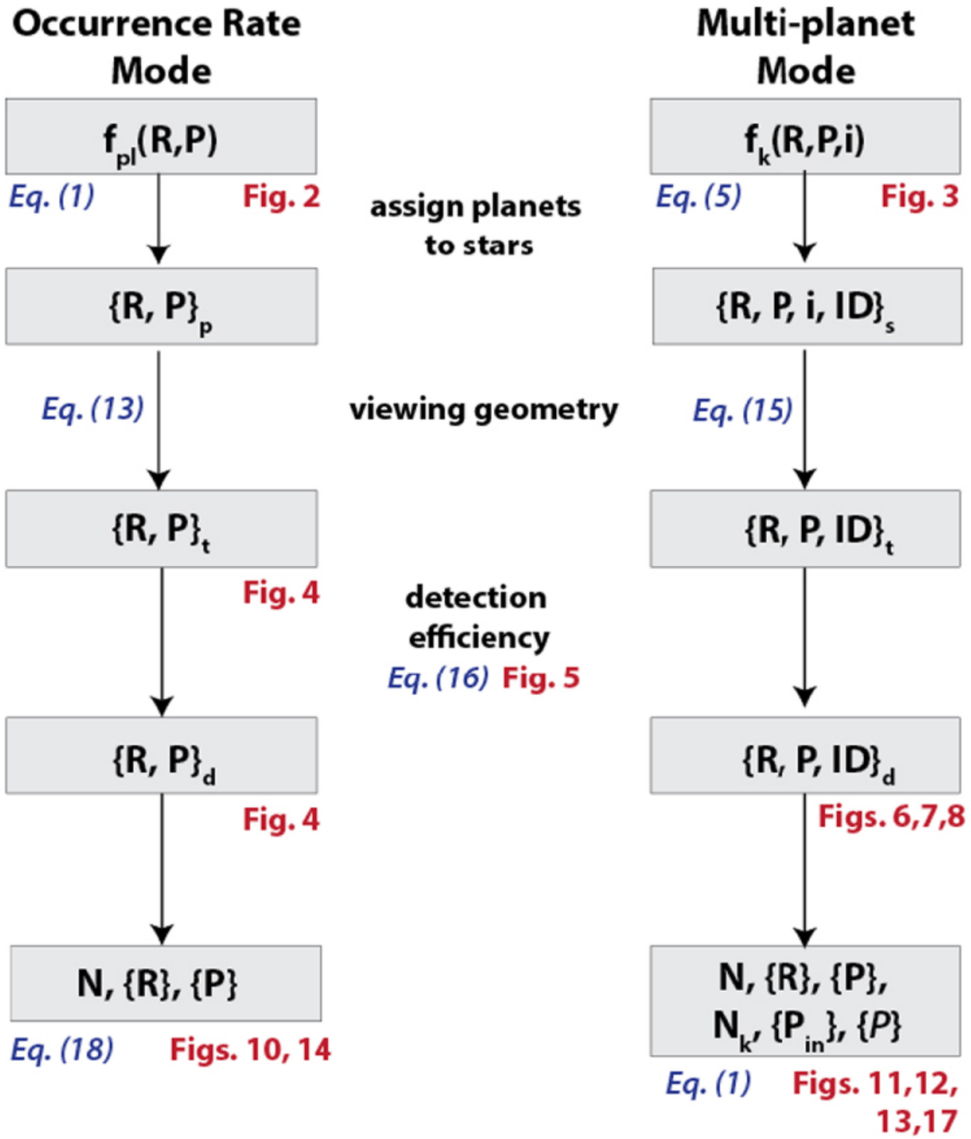
EPOS High-level Flowchart

Mulders et al. (2018)

Logical Steps



Quantitative Implementation



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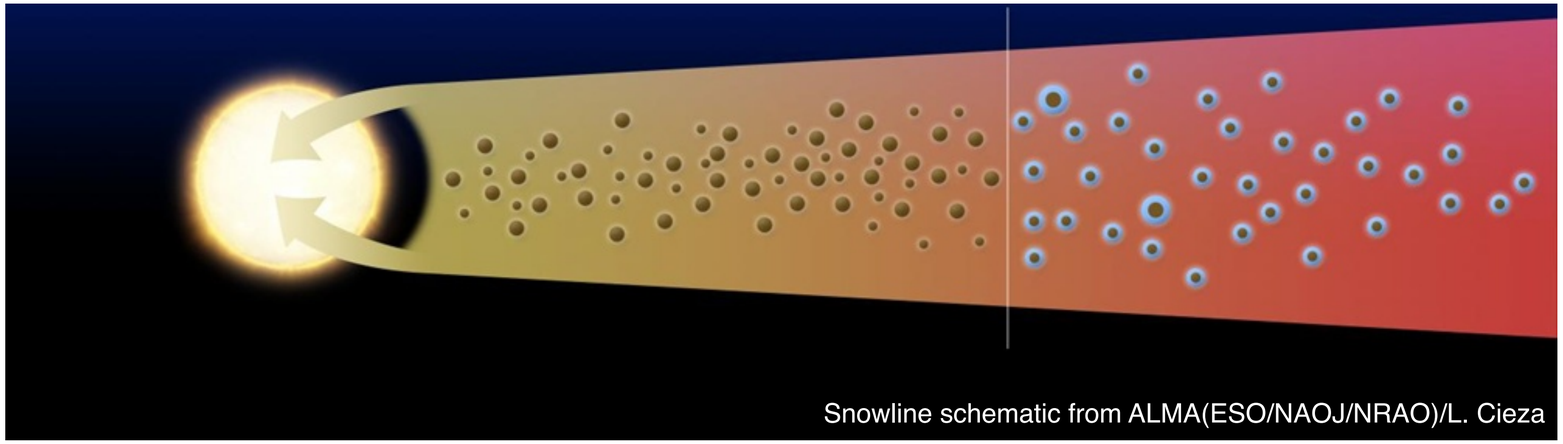

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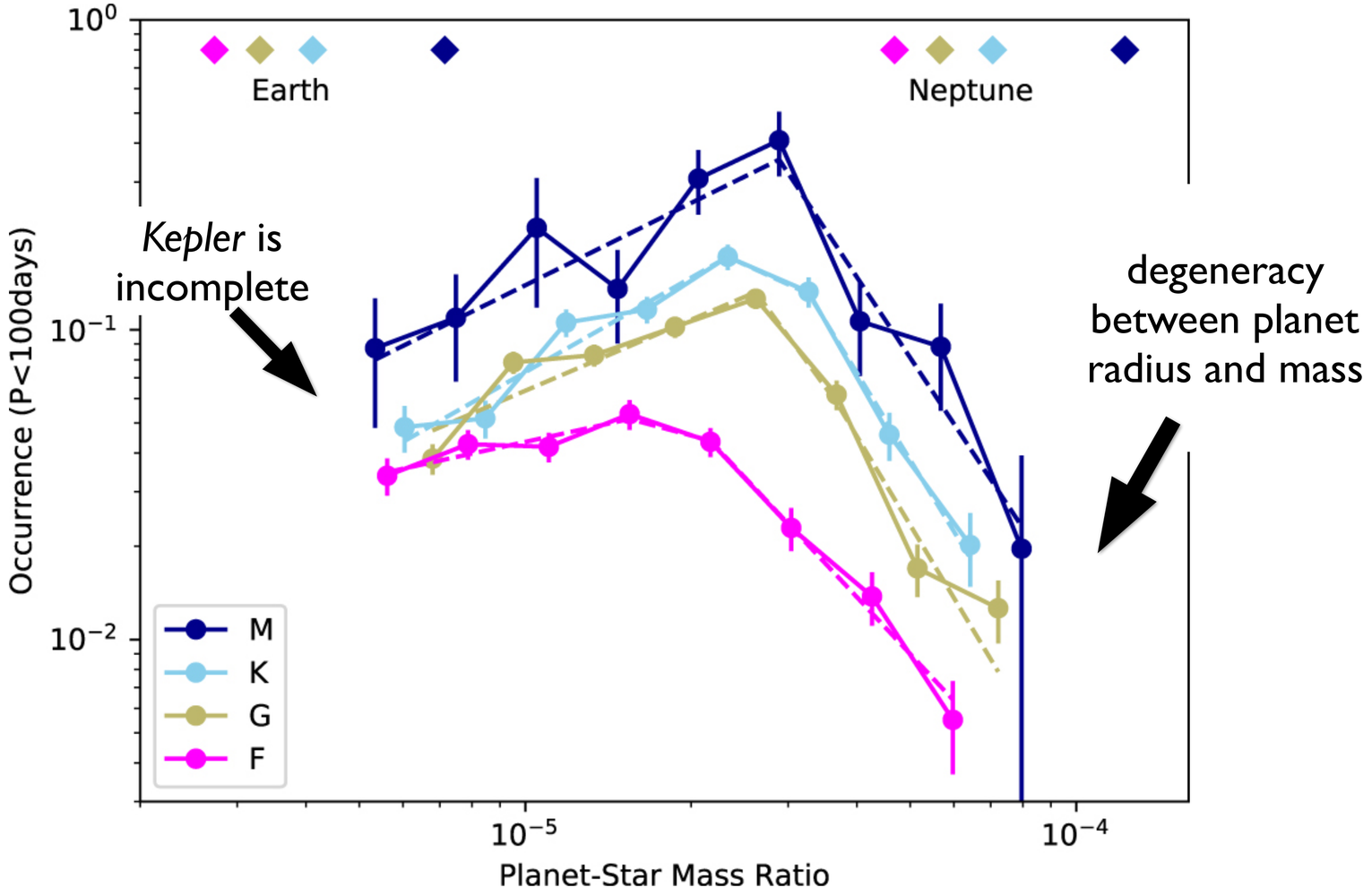
Kepler exoplanets, i.e. planets inside the snowline



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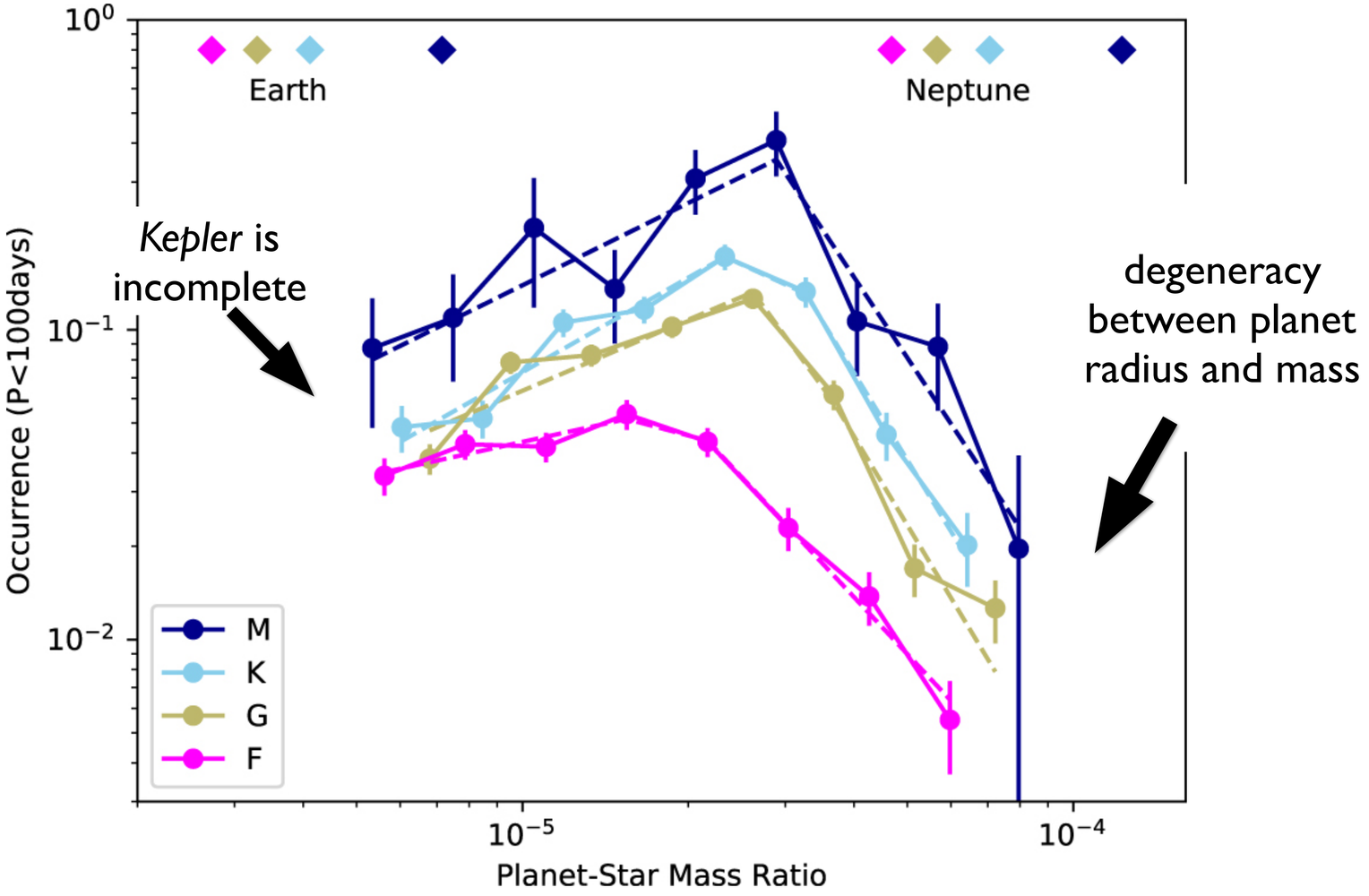

$$\frac{dN}{d\log q} = A\left(\frac{q}{q_{\rm br}}\right)^n$$

Pascucci et al. (2018)

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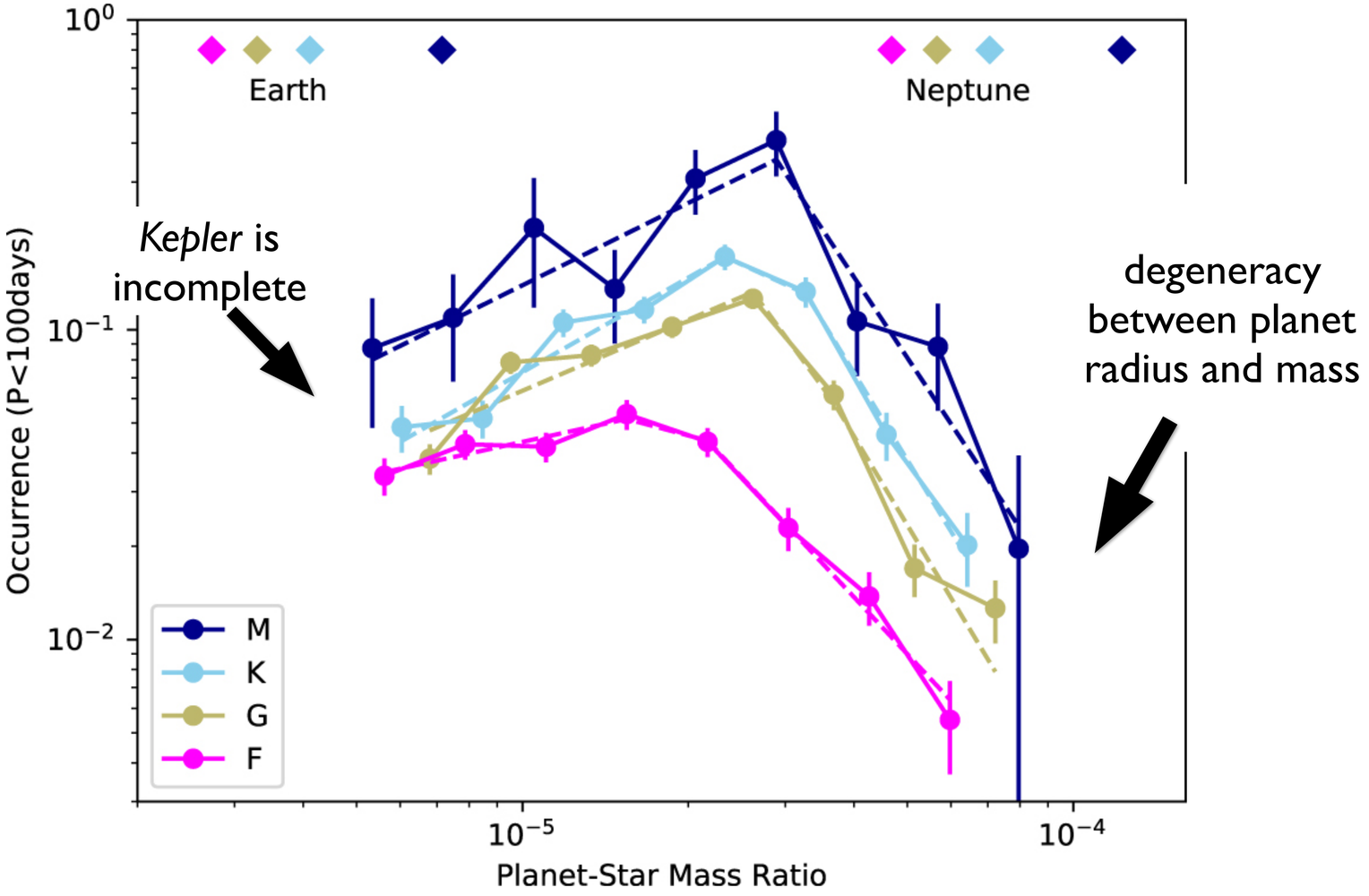


$$\frac{dN}{d\log q} = A\left(\frac{q}{q_{\rm br}}\right)^n$$

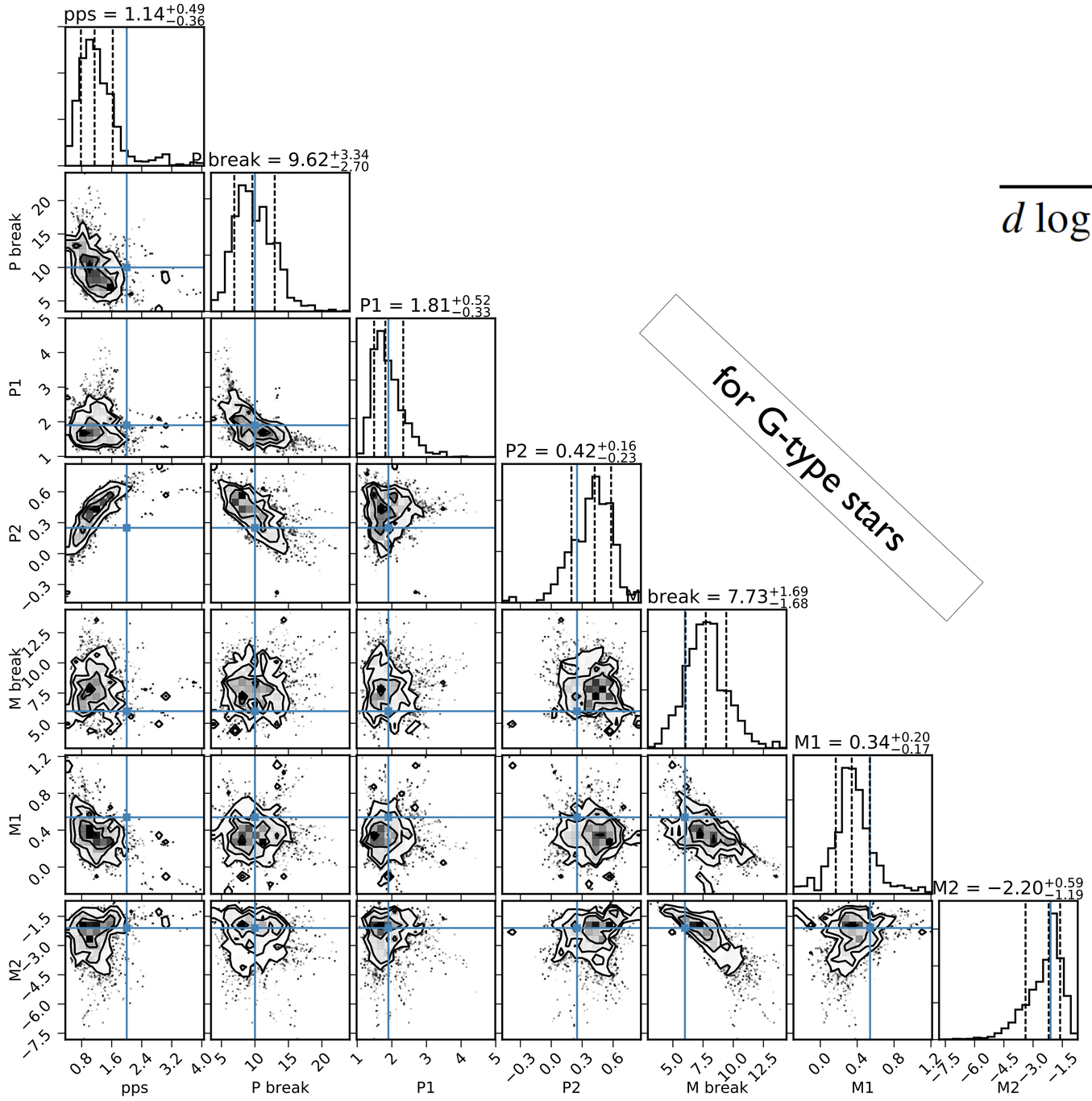
Except for a normalization factor, low-mass stars share the same broken power law with:

$q_{br} \sim 3\text{x}10^{-5}$

i. e., the mass of the most common planet scales linearly with stellar mass

Pascucci et al. (2018)

EPOS



for G-type stars

$$\frac{dN}{d\log P\, d\log M} = c_0 f(P) f(M)$$

$$f(P) = \begin{cases} \left(\frac{P}{P_{\rm br}}\right)^{P_1} & \text{if } P \leqslant P_{\rm br} \\ \left(\frac{P}{P_{\rm br}}\right)^{P_2} & \text{if } P > P_{\rm br} \end{cases}$$

$$f(M) = \begin{cases} \left(\frac{M}{M_{\rm br}}\right)^{M_1} & \text{if } M \leqslant M_{\rm br} \\ \left(\frac{M}{M_{\rm br}}\right)^{M_2} & \text{if } M > M_{\rm br} \end{cases}$$

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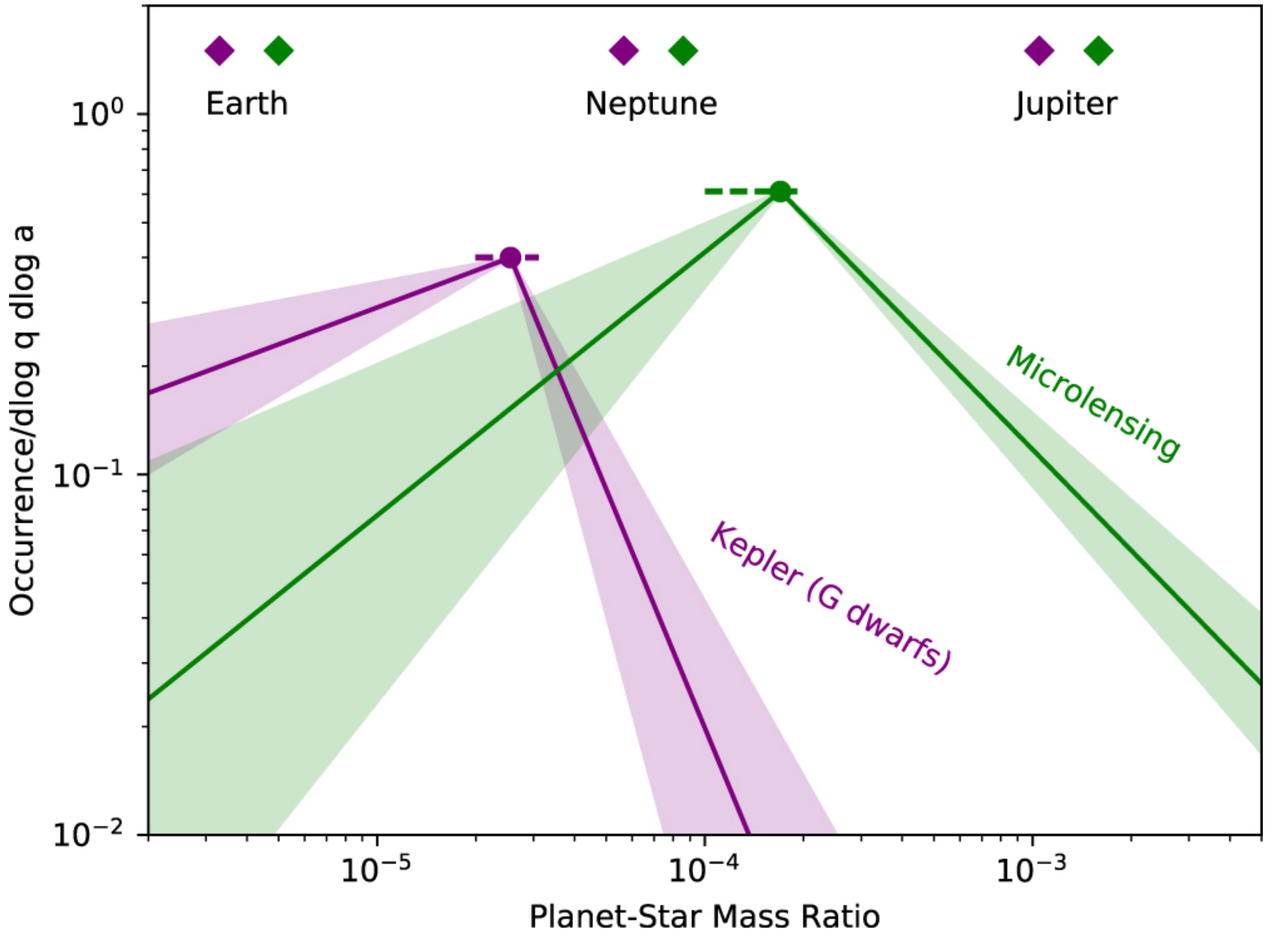

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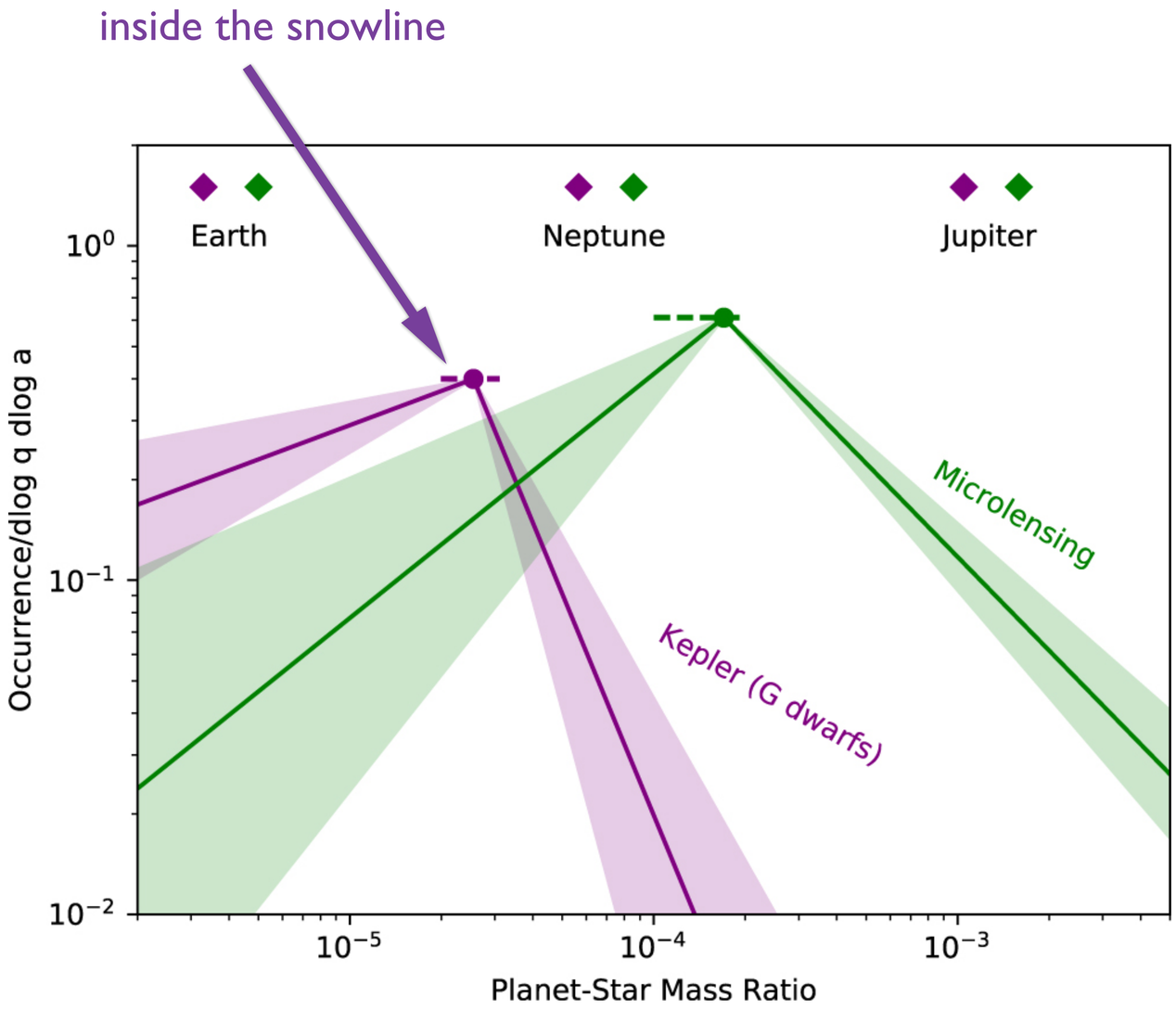

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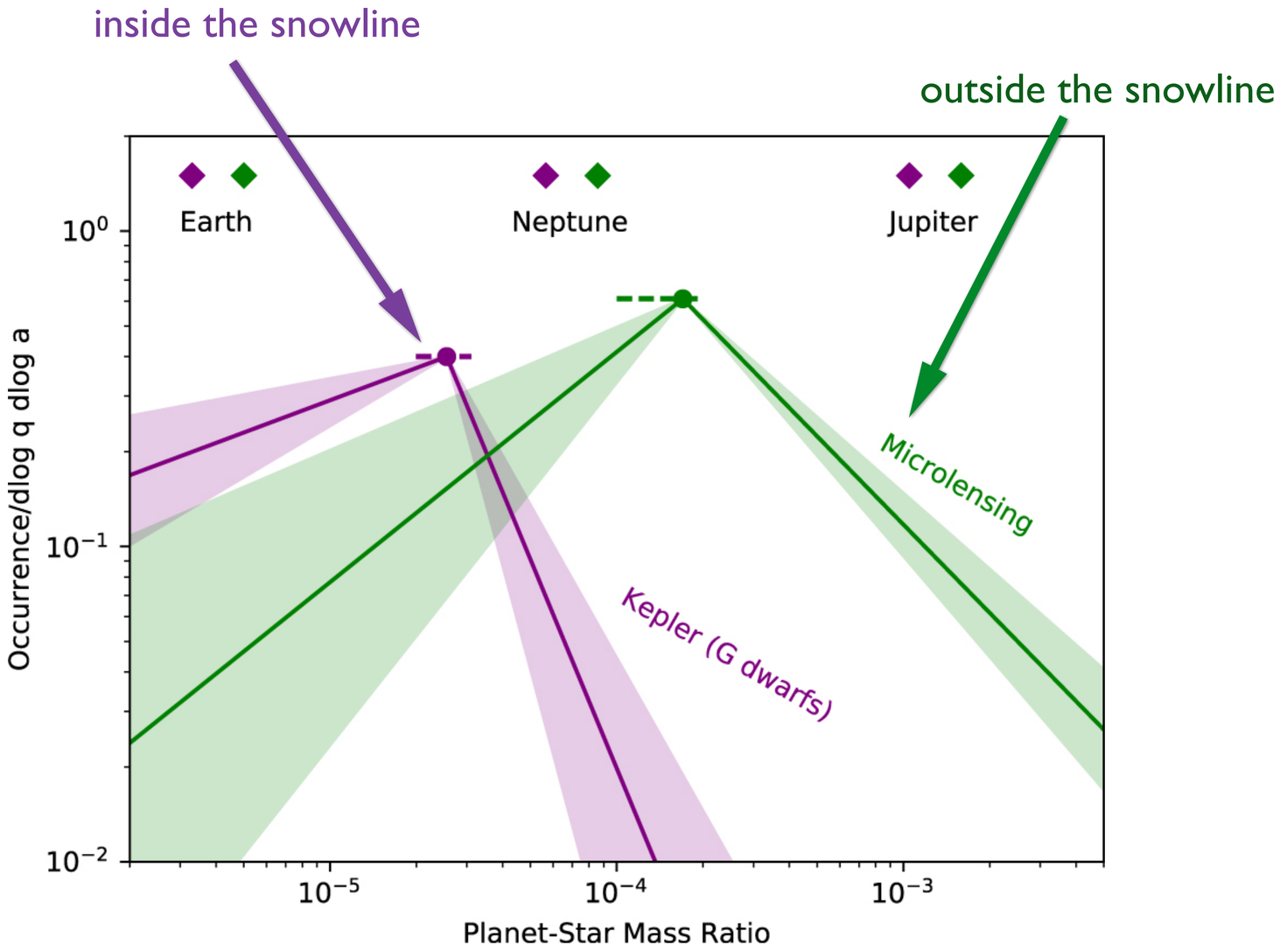
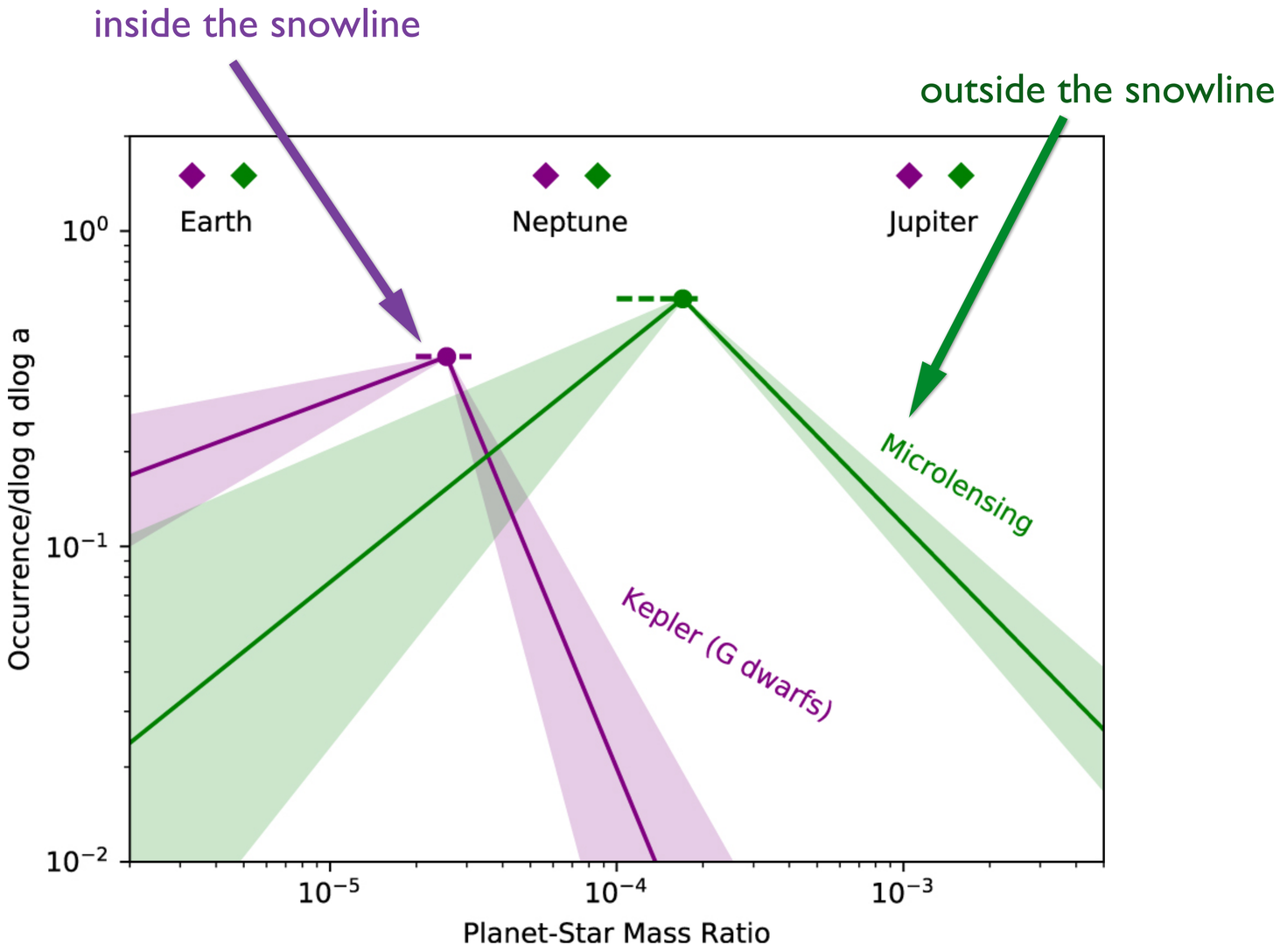


Microlensing results from Suzuki et al. (2016) and Udalski et al.(2018)

Pascucci et al. (2018)



the q_{br} for planets outside the snowline is ~3-10 times higher than that for planets inside

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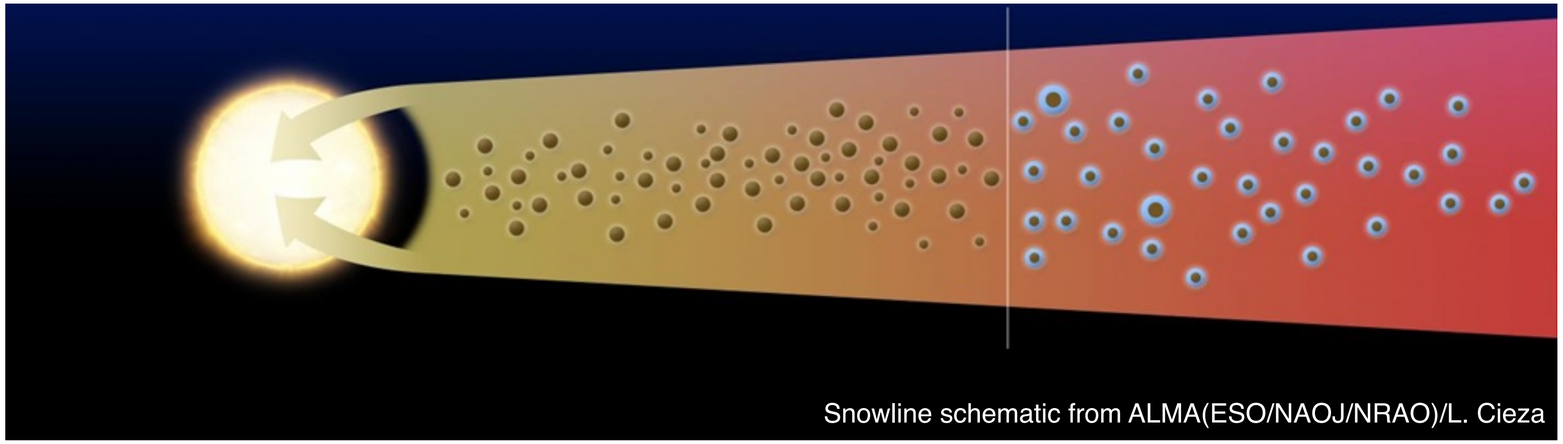

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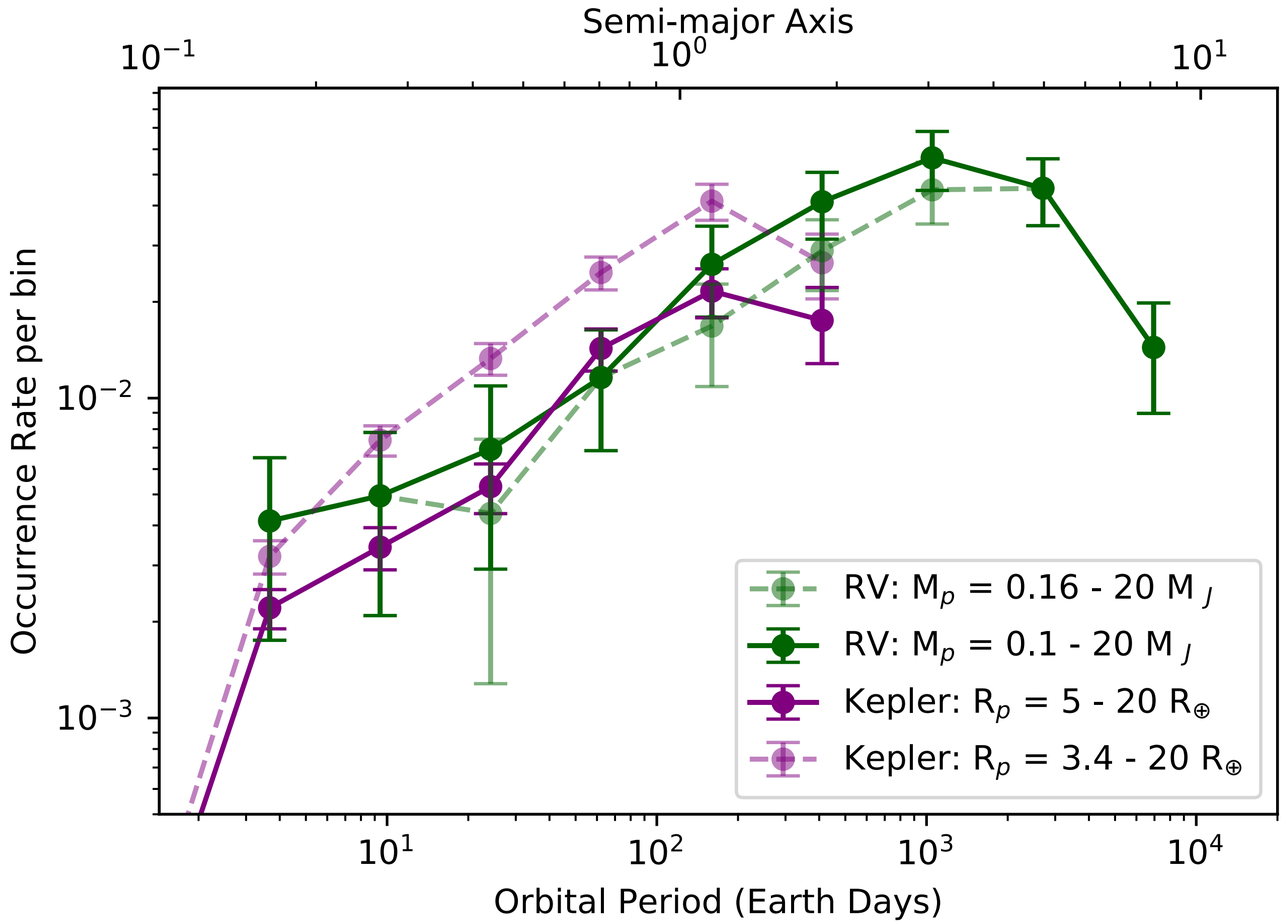
Kepler and RV comparison…



RV completeness curve from Major et al. (2011)

Fernandes et al. (arXiv:1812.05569)

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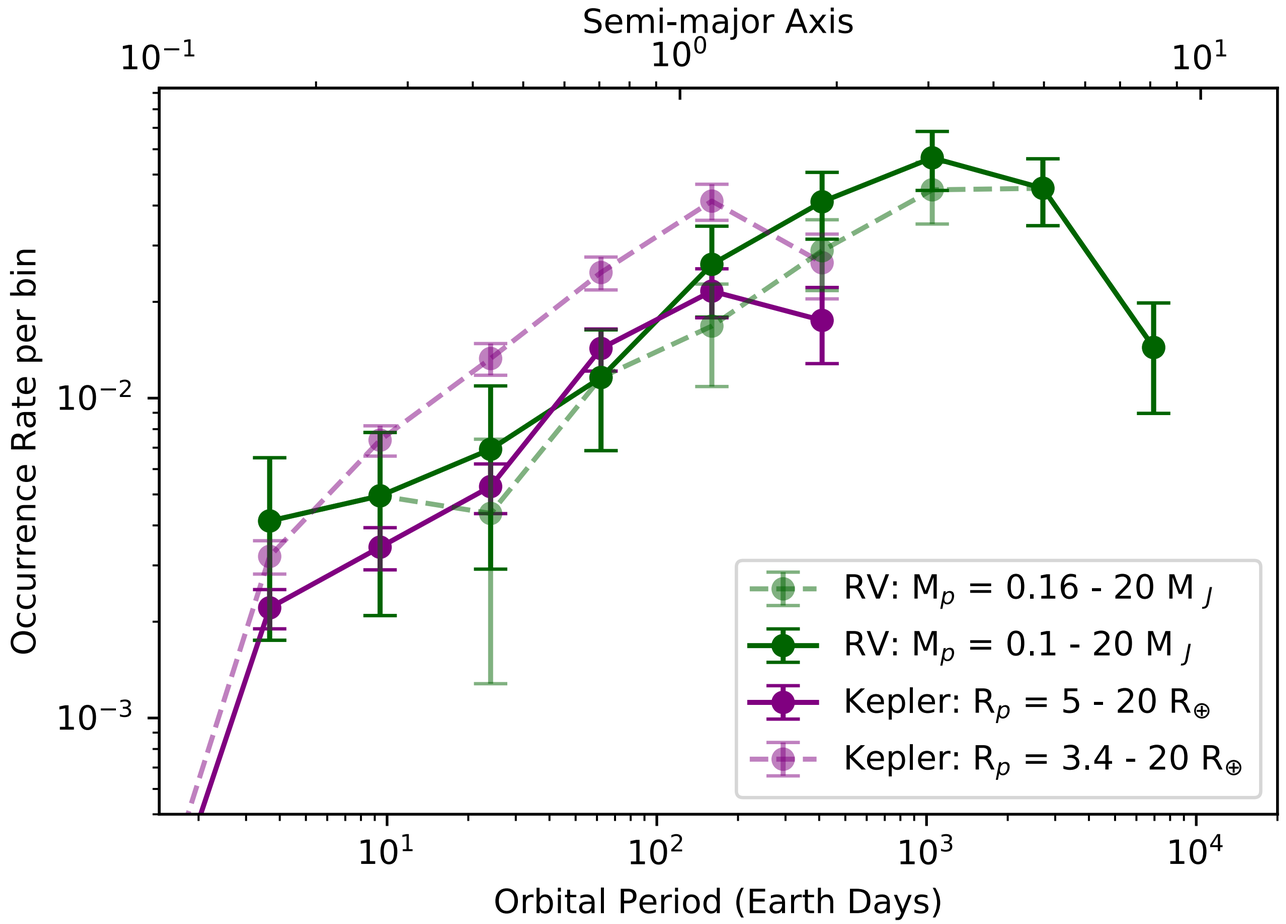

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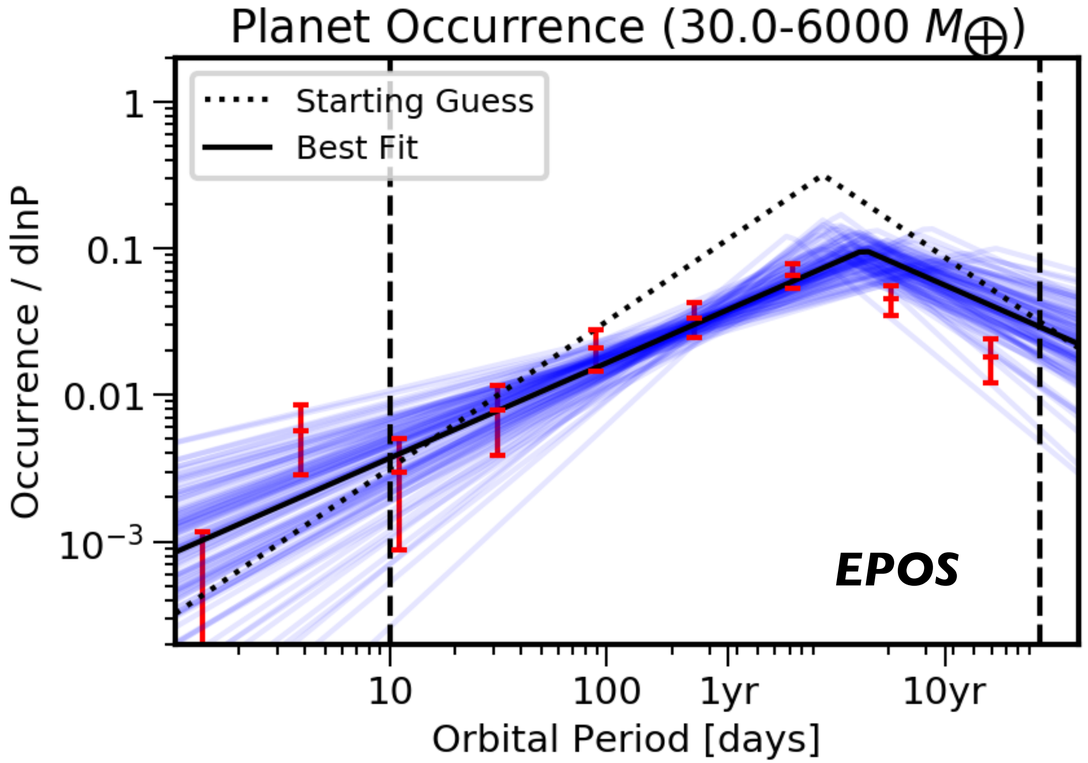

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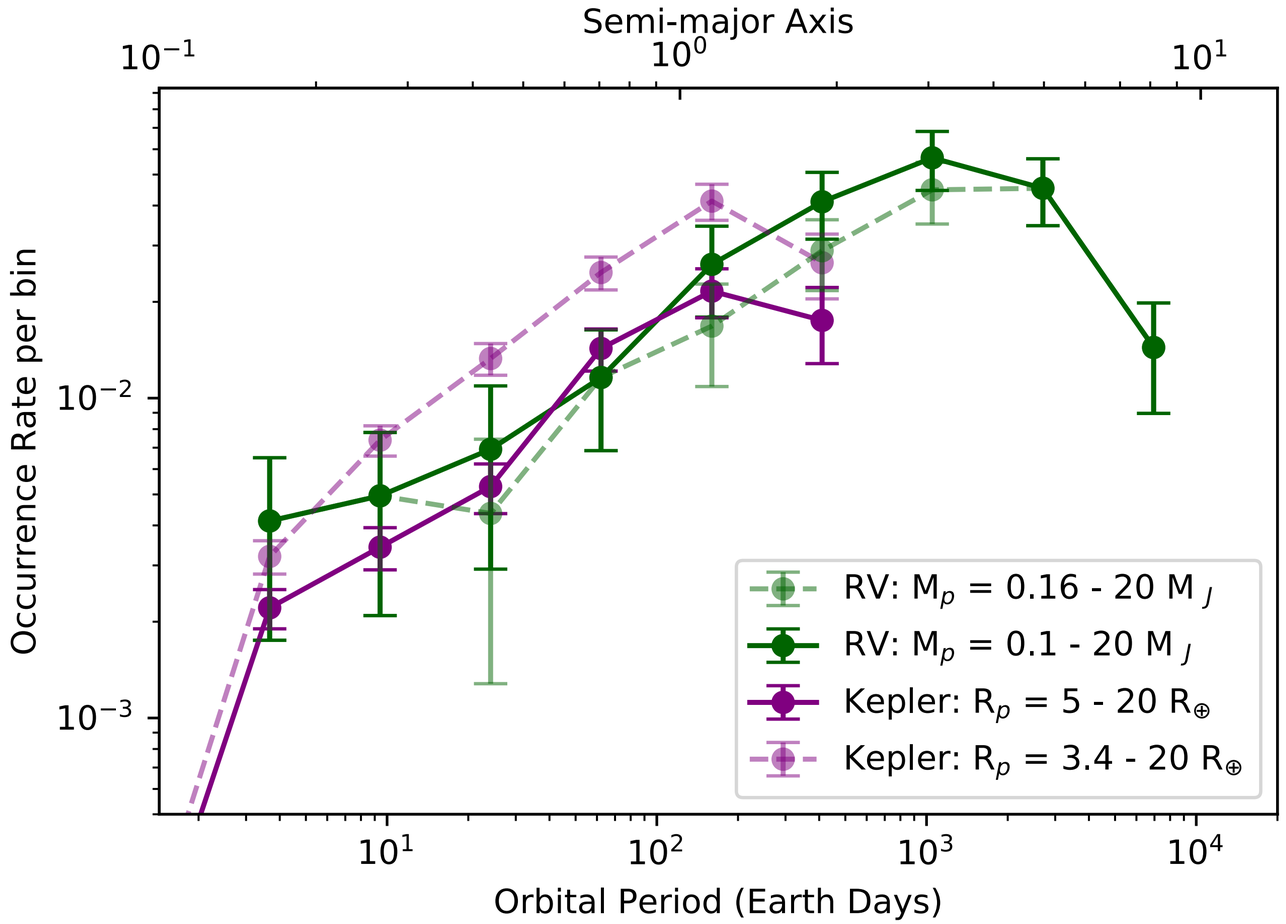
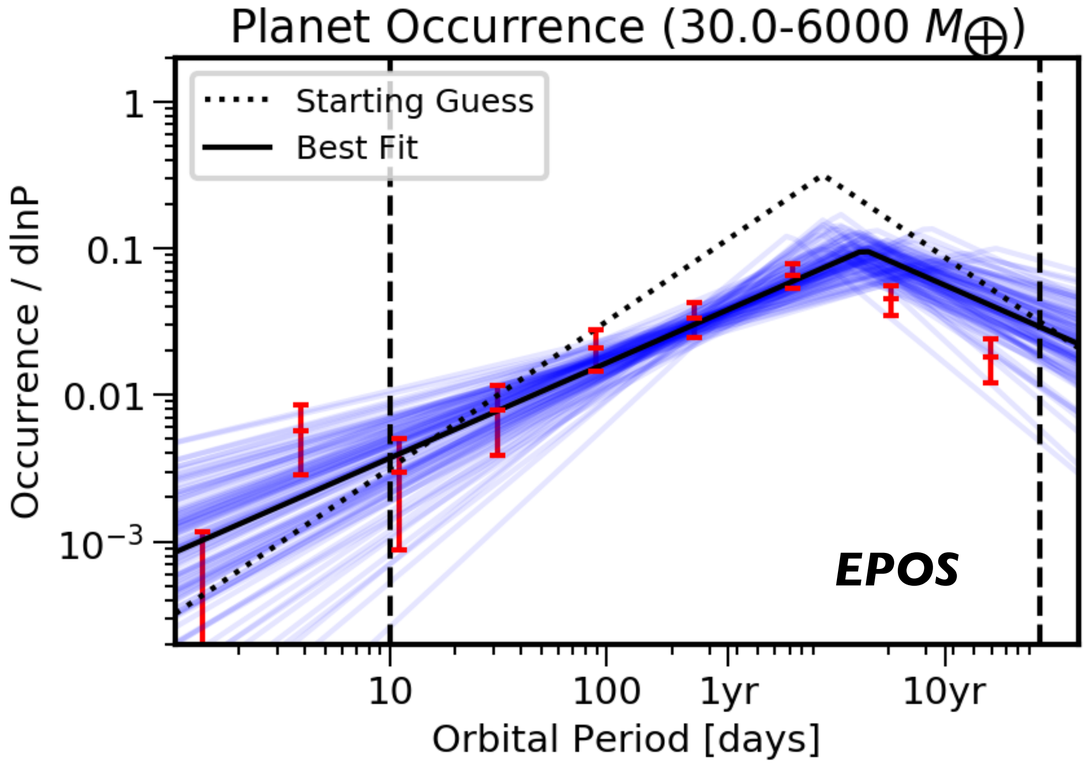
Kepler and RV comparison…

Turnover in the giant planet occurrence rate at ~2-3au (snowline?)





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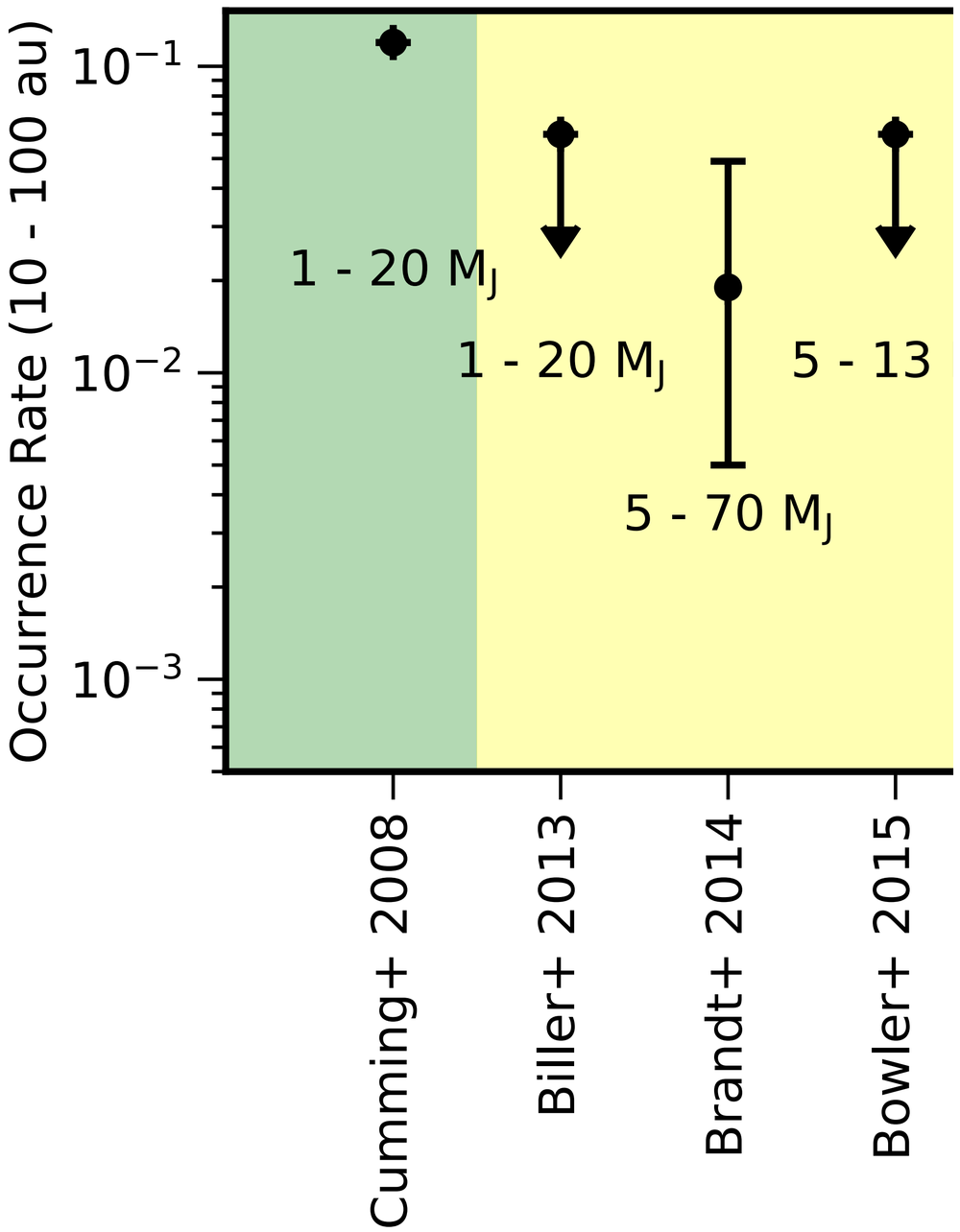

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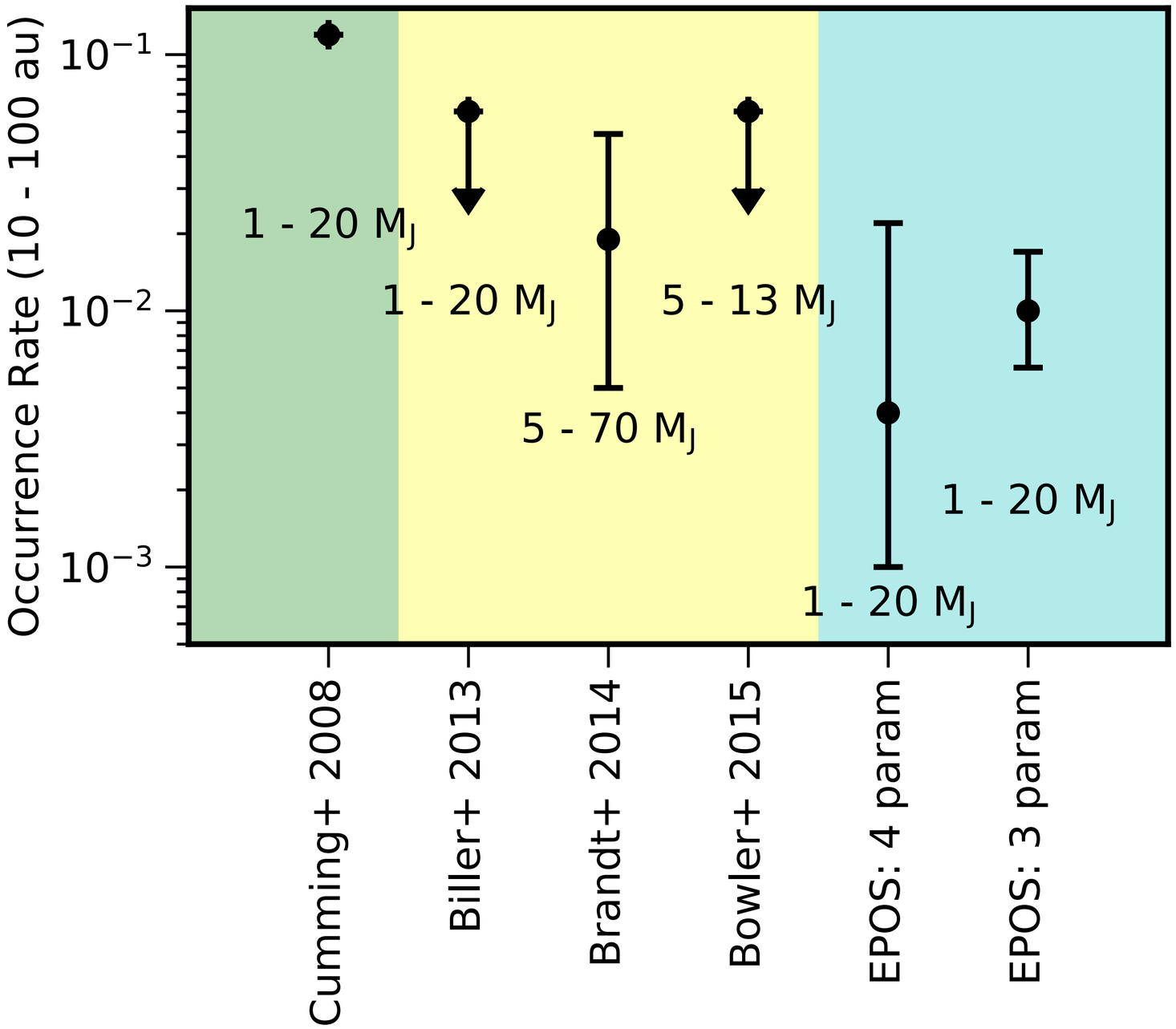

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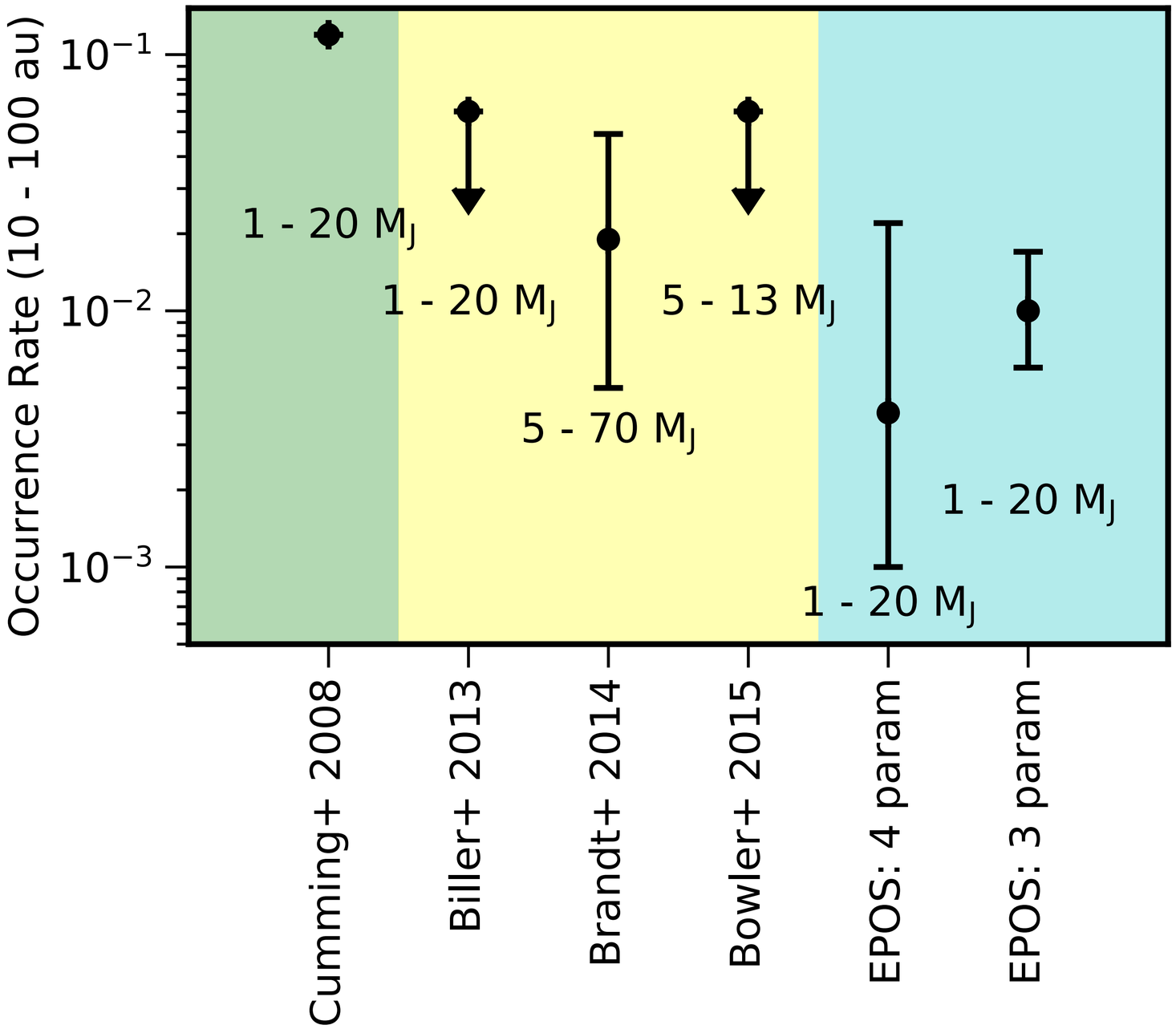
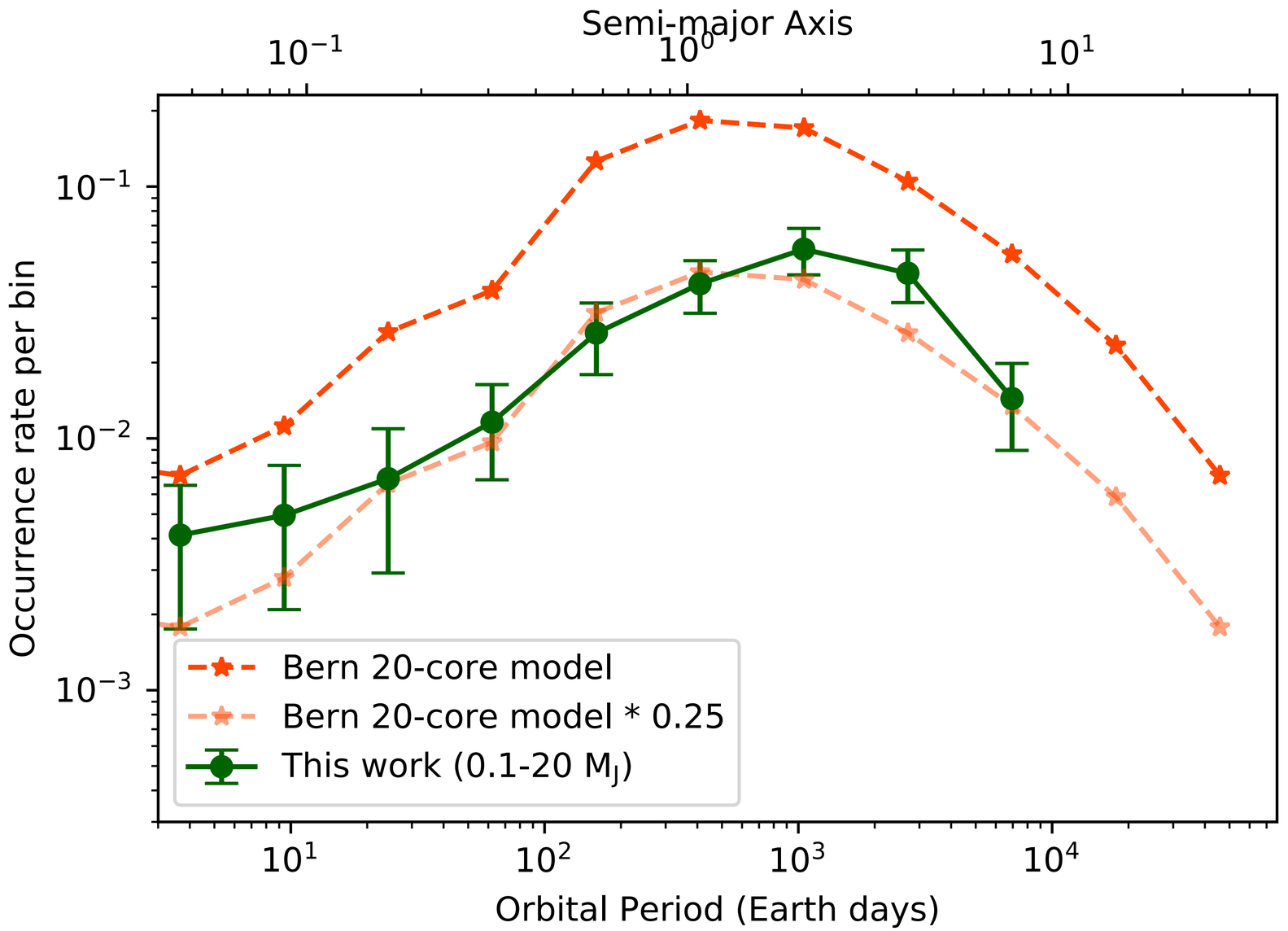


Our best fit curve is consistent with the low detection rate of giant planets at >10au

Fernandes et al. (arXiv:1812.05569)

In the Bern population synthesis models the pile-up of giant planets is due to the snowline and disk dispersal (star-driven photo evaporation)



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Conclusions

Pascucci et al. 2018 (ApJ, 856L, 28): Kepler + microlensing occurrence rates

- The mass of the most common planet inside the snowline scales linearly with stellar mass
- The most common planet inside the snowline is ~3-10 times less massive than the one outside

Fernandes et al. 2018 (arXiv:1812.05569): Kepler + RV occurrence rates

- Same occurrence within ~200 days
- There is a turnover in the giant planet occurrence rate at the snowline