the Exoplanet ″/p⊕s Population Observation Simulator

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EOS/NExSS

Planet Formation Models vs. Observed Exoplanets



(see also Remo Burn's talk)



https://github.com/GijsMulders/epos



- Mulders+ 2018
- Pascucci+ 2018; 2019



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- Pascucci+ 2018; 2019



- Mulders+ 2018
- Pascucci+ 2018; 2019
- Fernandes+ 2019



- Mulders+ 2018
- Pascucci+ 2018; 2019
- Fernandes+ 2019
- Mulders+ 2019
- Mulders+ 2020 in prep

Mo 11:10 am session 224

EPOS and eta_earth





Kepler has detected no reliable earth sized planet candidates in the habitable zone of sun-like stars

data from Thompson+ 2018, Berger+2019

Estimating underlying distribution



Estimating underlying distribution



| Model | Fitted P | Fitted R | Function | Γ_{\oplus} | η_\oplus |
|-------|----------|------------|-----------|-----------------------------|------------------------------|
| # | days | R_\oplus | | % | % |
| 1 | 2–400 | 0.5–6 | 2D broken | $59.6^{+21.8}_{-25.4}$ | $40.6^{+14.9}_{-17.3}$ |
| 2 | 2–400 | 0.5-2 | P broken | $78.7^{+43.5}_{-39.2}$ | $53.6^{+29.7}_{-29.7}$ |
| 3 | 12-400 | 0.5-6 | R broken | $17.0^{+7.6}_{-5.6}$ | $11.5_{-3.8}^{+5.2}$ |
| 4 | 12-400 | 1–6 | R broken | $16.0\substack{+8.0\\-5.5}$ | $10.9\substack{+5.5\\-3.7}$ |
| 5 | 25-400 | 0.5-6 | R broken | $8.6^{+8.9}_{-5.1}$ | $5.9\substack{+6.0 \\ -3.5}$ |
| 6 | 25-400 | 1–6 | R broken | $8.0\substack{+10.3\\-5.4}$ | $5.4\substack{+7.0\-3.7}$ |

(Mulders+ 2018)

Pascucci+ 2019

Estimating underlying distribution



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(Mulders+ 2018)

Pascucci+ 2019

Rocky planets are over-represented at short periods, leading to overestimate of eta_earth (Lopez & Rice 2018)

Need a physically motivated planet distribution that describes covariance in period and radius

Planet Population Synthesis

Planet Population Synthesis



Bern Model (Mordasini 2018, Emsenhuber in prep)



(consistent with Pascucci+ 2019)



Summary

- EPOS is a framework for estimating exoplanet distributions from biased surveys (e.g. Kepler)
- In the absence of reliable planet candidates, eta_earth can only be estimated by extrapolation
- Presence of stripped cores at short periods leads to overestimate of eta_earth
- Occurrence of habitable zone rocky planets may be smaller than eta_earth (!)