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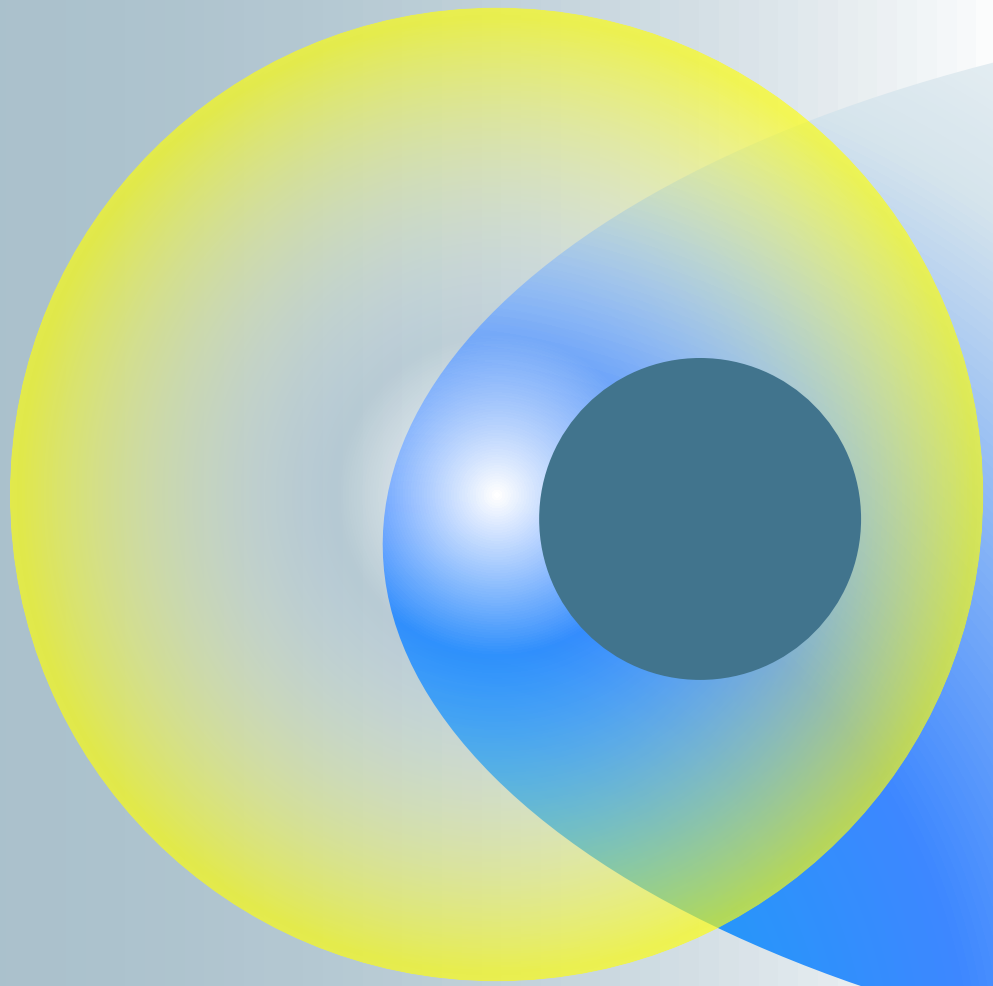
THE MASS-RADIUS RELATION OF INTERMEDIATE-MASS PLANETS OUTLINED BY HYDRODYNAMIC ESCAPE AND THERMAL EVOLUTION

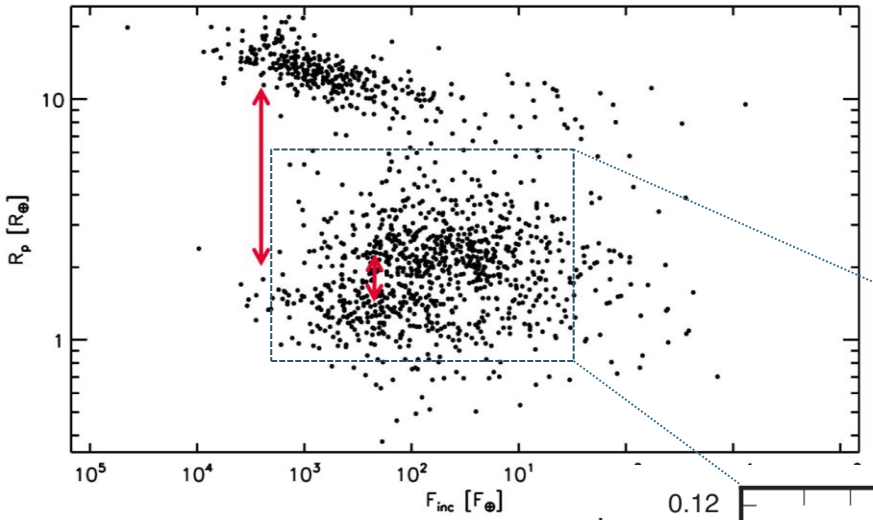


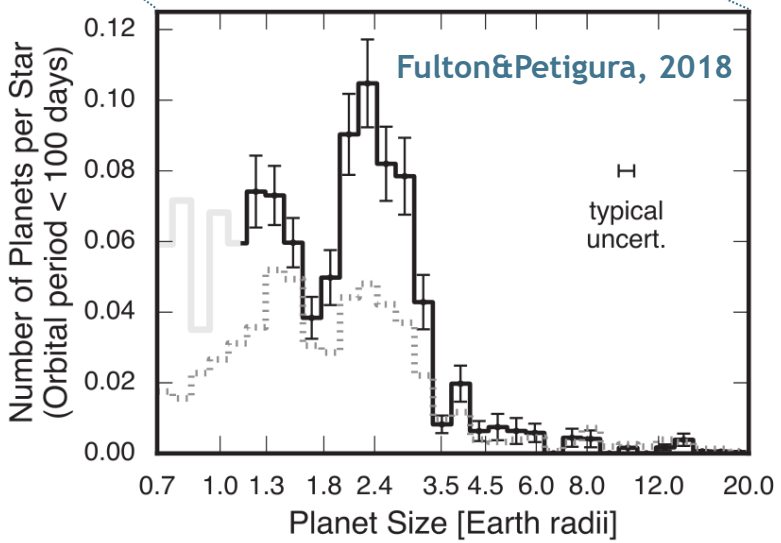
Daria Kubyshkina

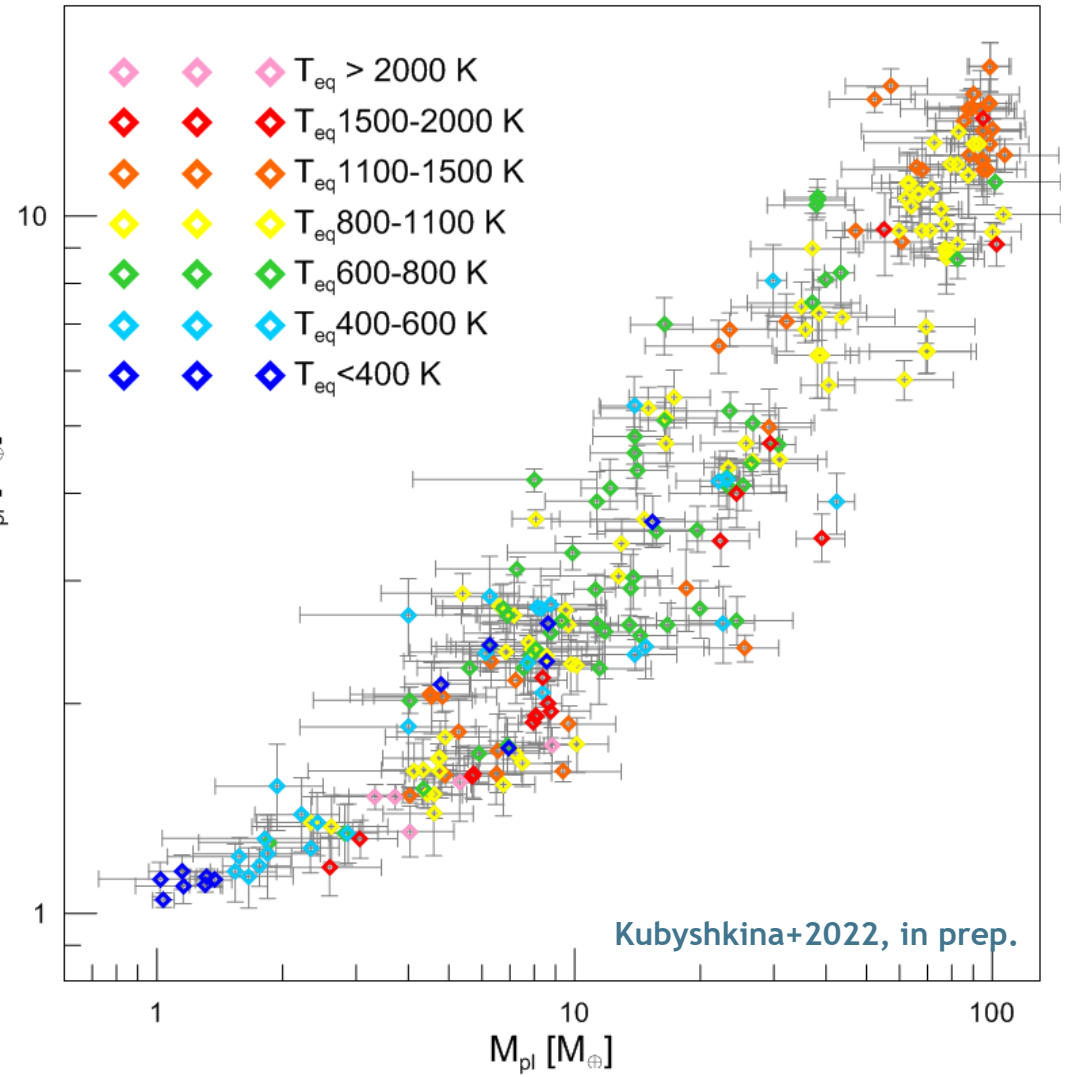
Institut für Weltraumforschung
Österreichische Akademie der Wissenschaften

MASS-RADIUS RELATION OF THE INTERMEDIATE MASS PLANETS

Mullally et al. 2015







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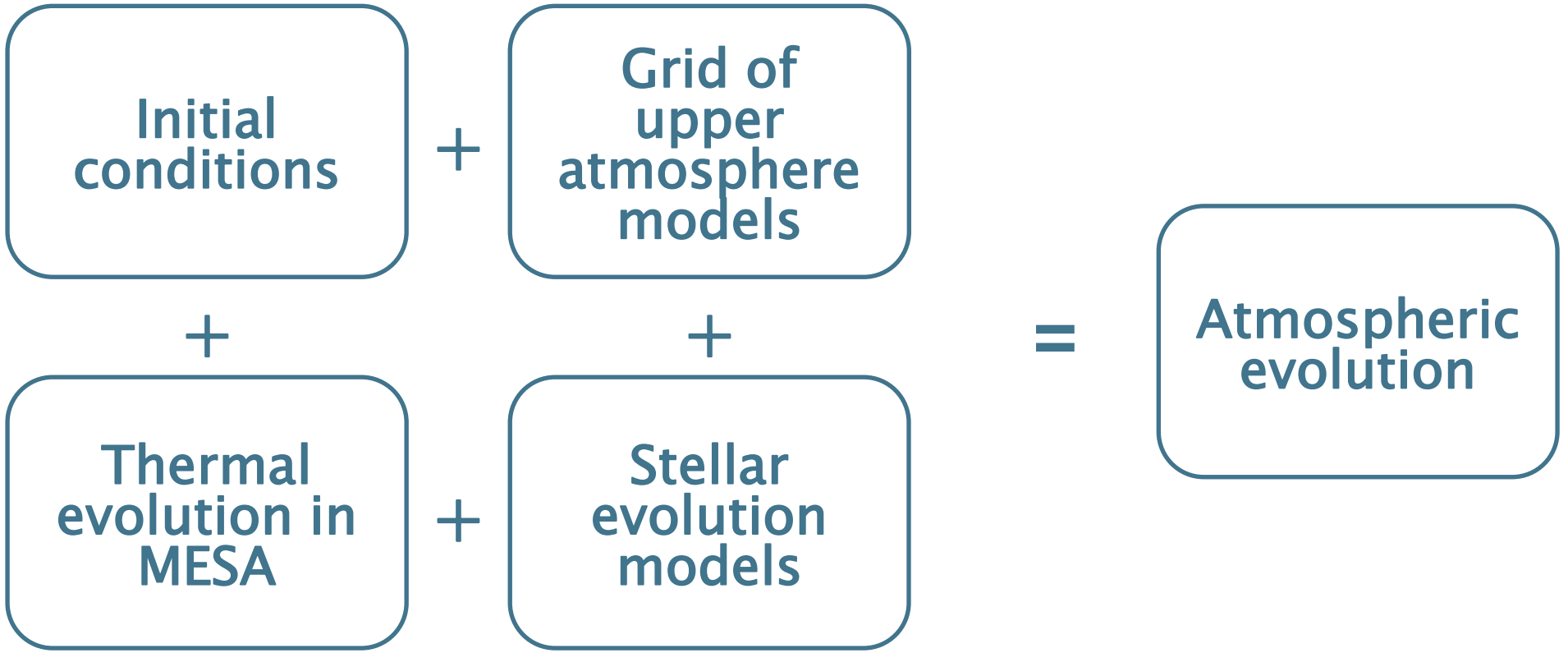
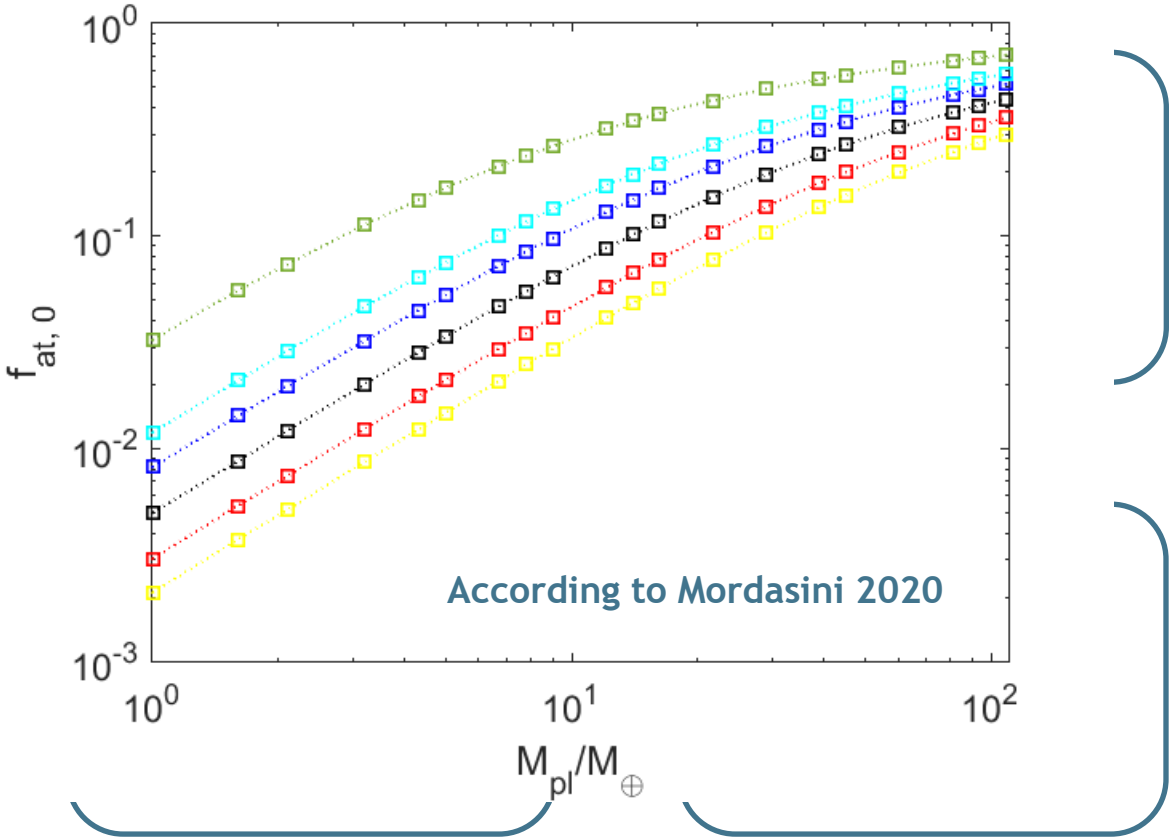
ATMOSPHERIC EVOLUTION: MASS LOSS AND THERMAL CONTRACTION



Kubyshkina et al., 2020, Kubyshkina&Vidotto 2021, Kubyshkina et al. 2022b

ATMOSPHERIC EVOLUTION: MASS LOSS AND THERMAL CONTRACTION



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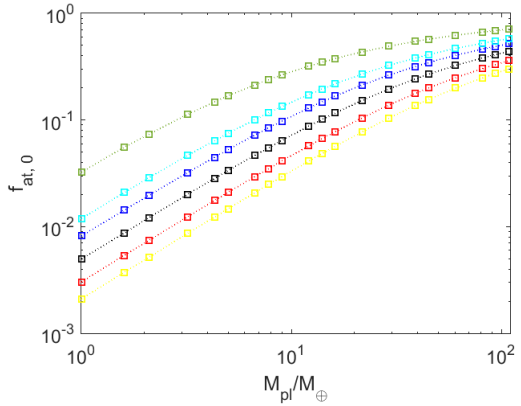
Atmospheric evolution

ATMOSPHERIC EVOLUTION: MASS LOSS AND THERMAL CONTRACTION



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Grid of upper atmosphere models

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Thermal evolution in MESA

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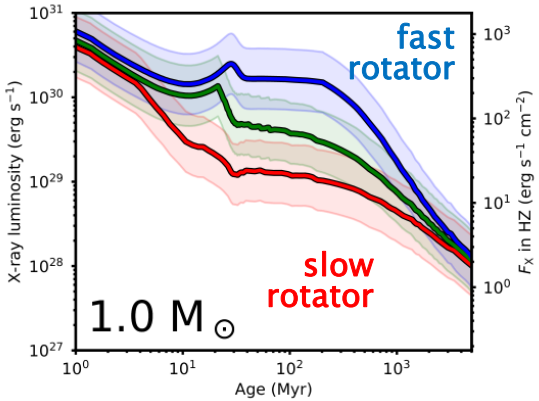

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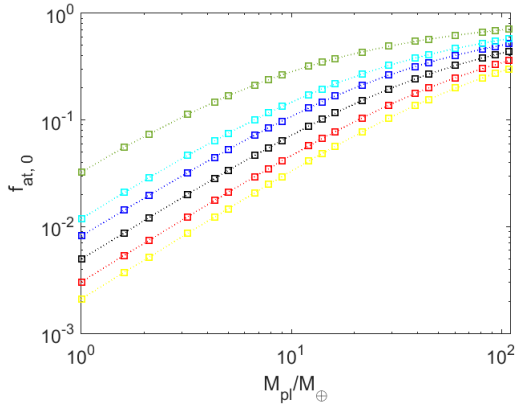
Atmospheric evolution

ATMOSPHERIC EVOLUTION: MASS LOSS AND THERMAL CONTRACTION



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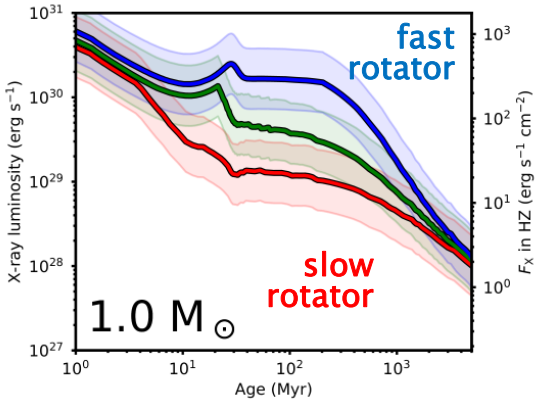

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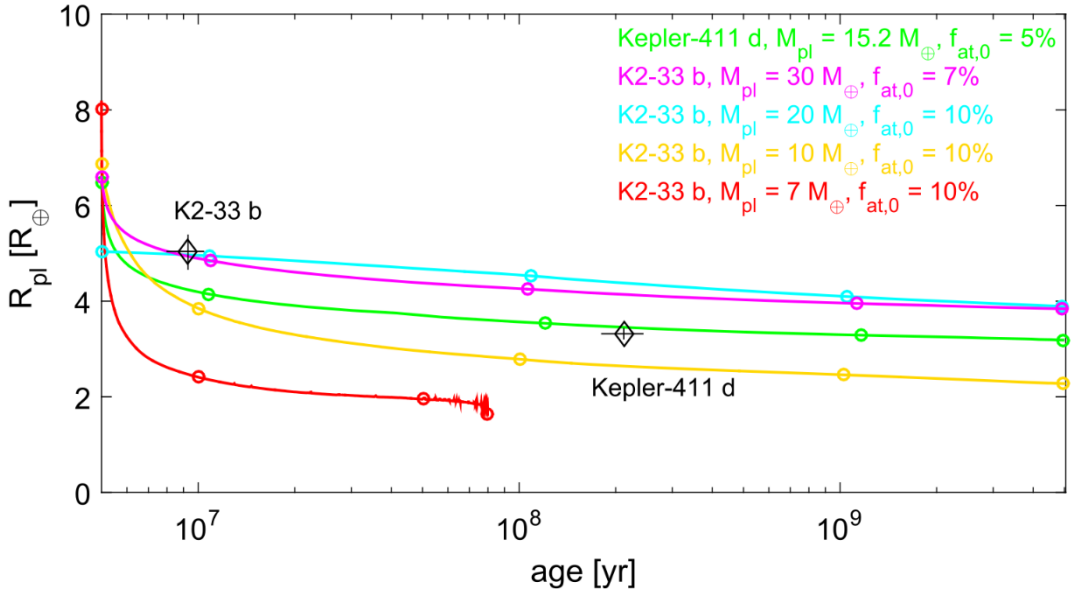
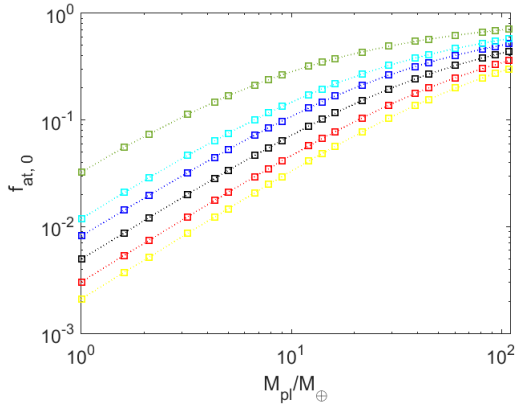


ATMOSPHERIC EVOLUTION: MODEL PLANETS



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Grid of upper atmosphere models

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Thermal evolution in MESA

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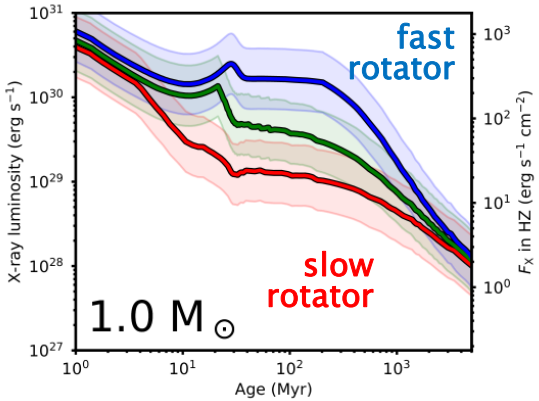
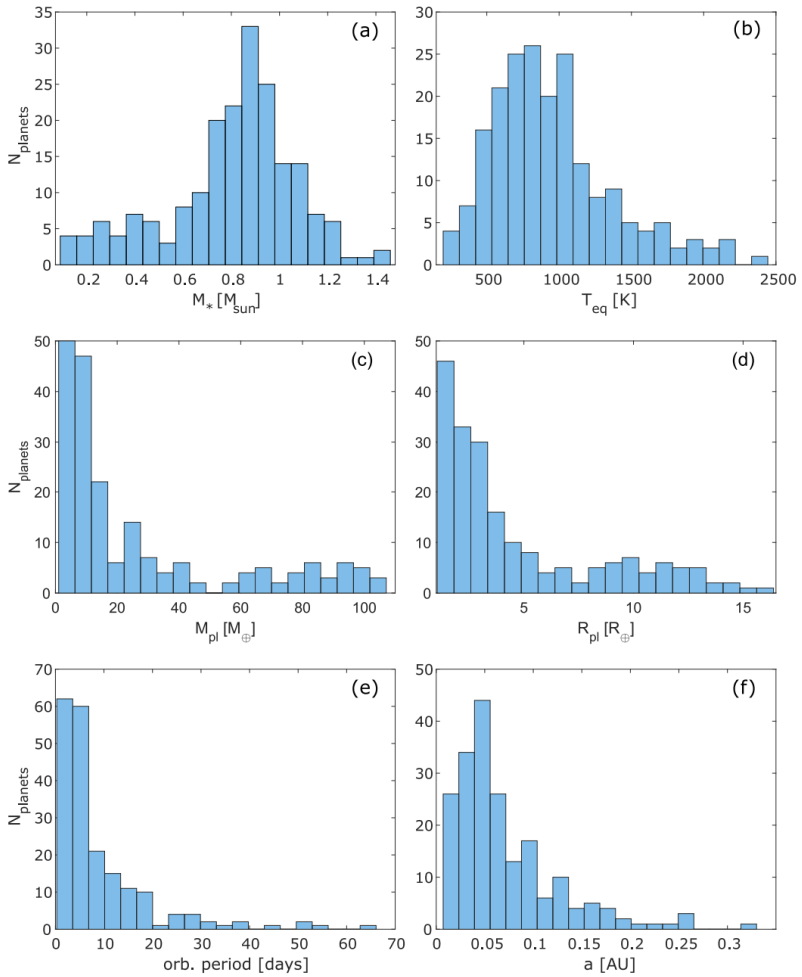
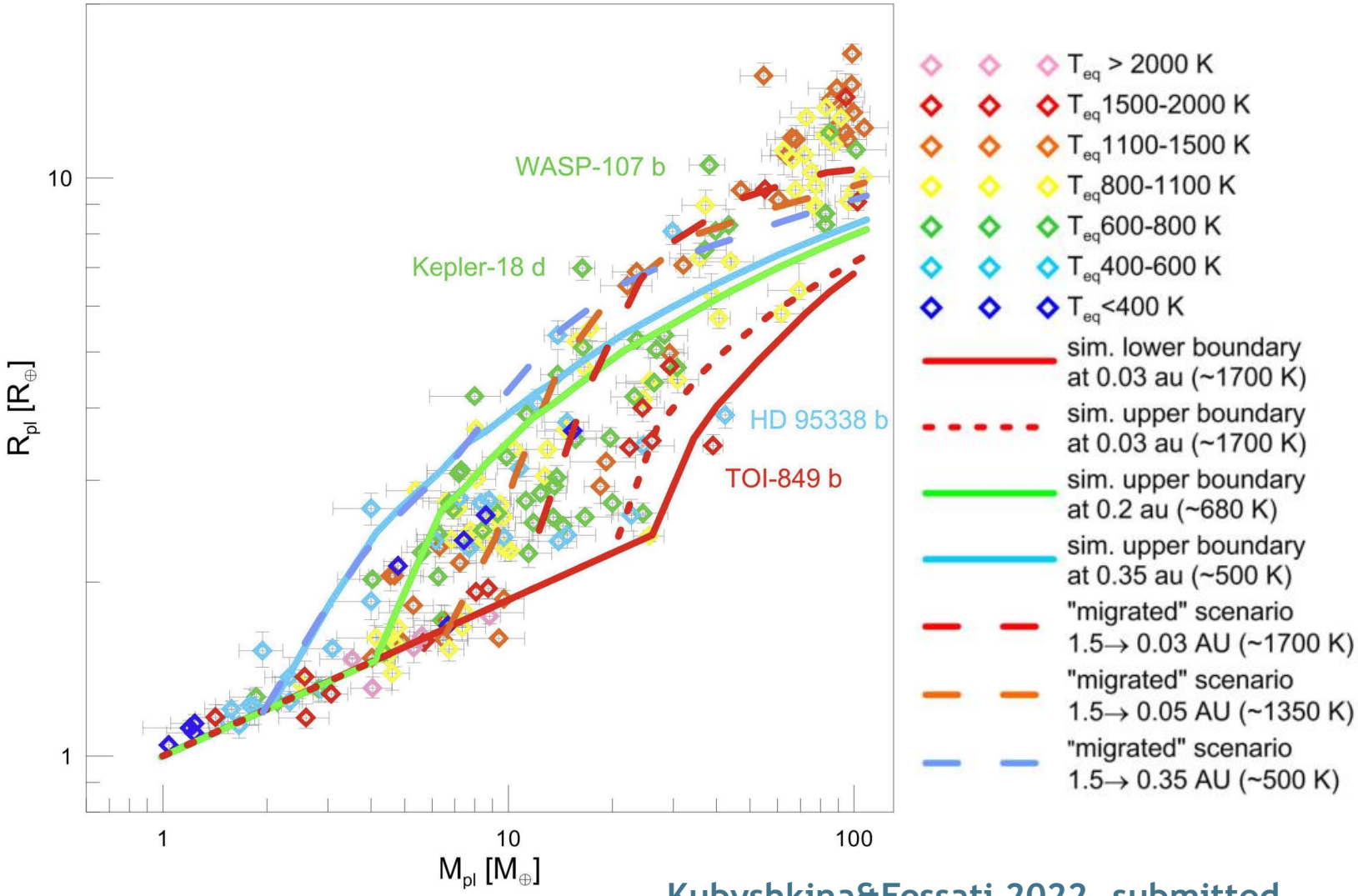


We run the evolution of model planets with masses of 1–110 $M_\oplus$ at orbits between 0.03–0.35 AU (~500–1700 K) orbiting 1 $M_\odot$ star evolving as slow/moderate/fast rotator.

We also account for two sets of initial conditions: estimation for the current position ("basic scenario") – 300 models, and assuming formation at 1.5 au ("migrated scenario") – 100 models (only the slow rotating star).

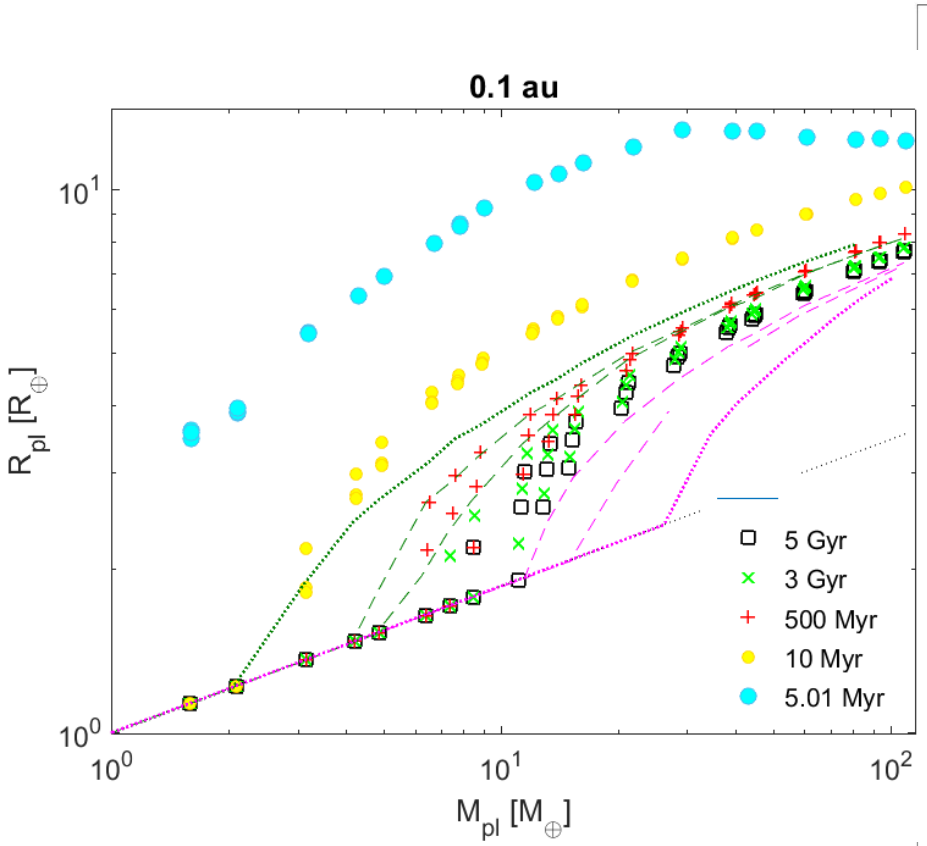
THE OBSERVED SPREAD IN MASS-RADIUS RELATION

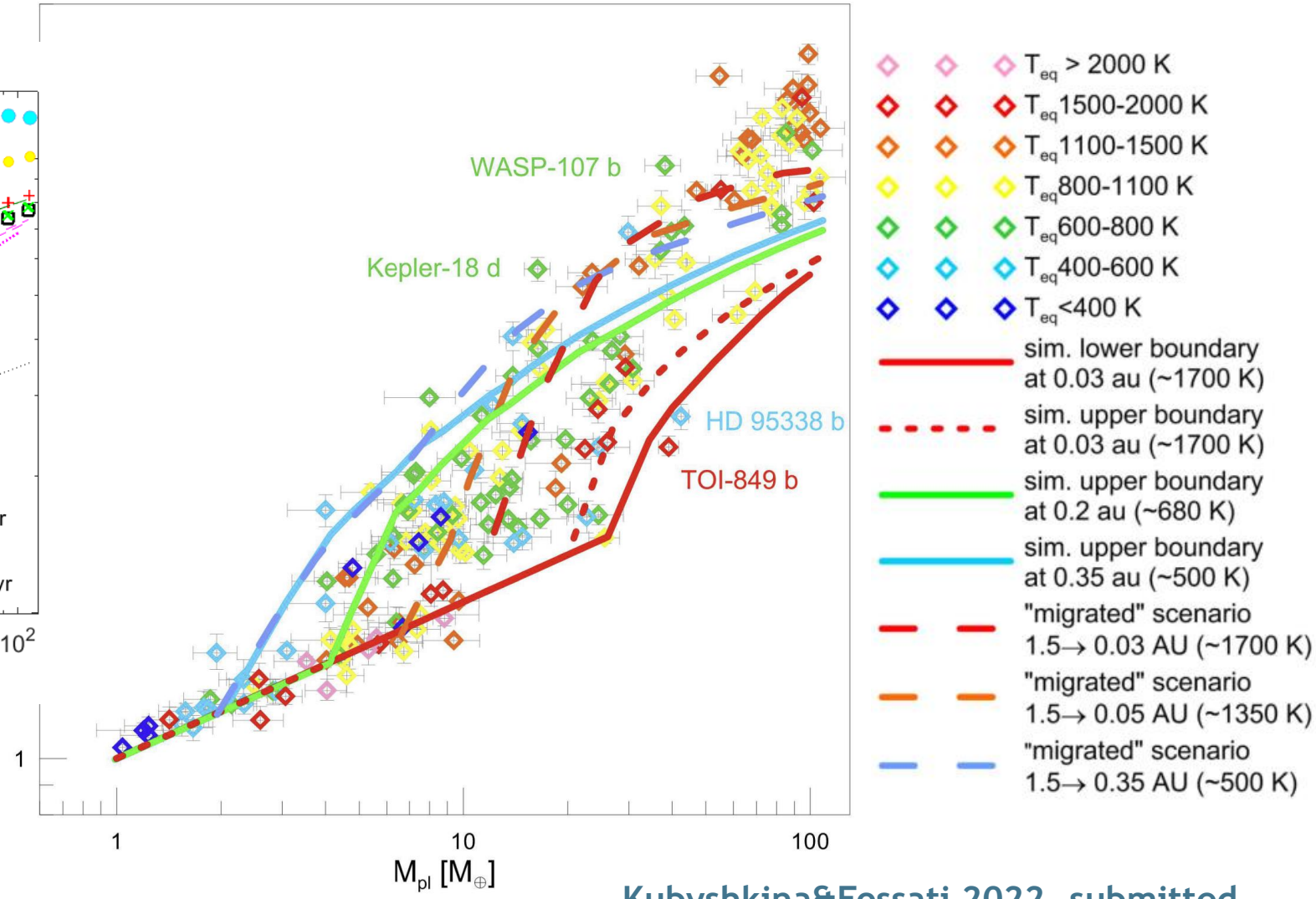




Kubyshkina&Fossati 2022, submitted

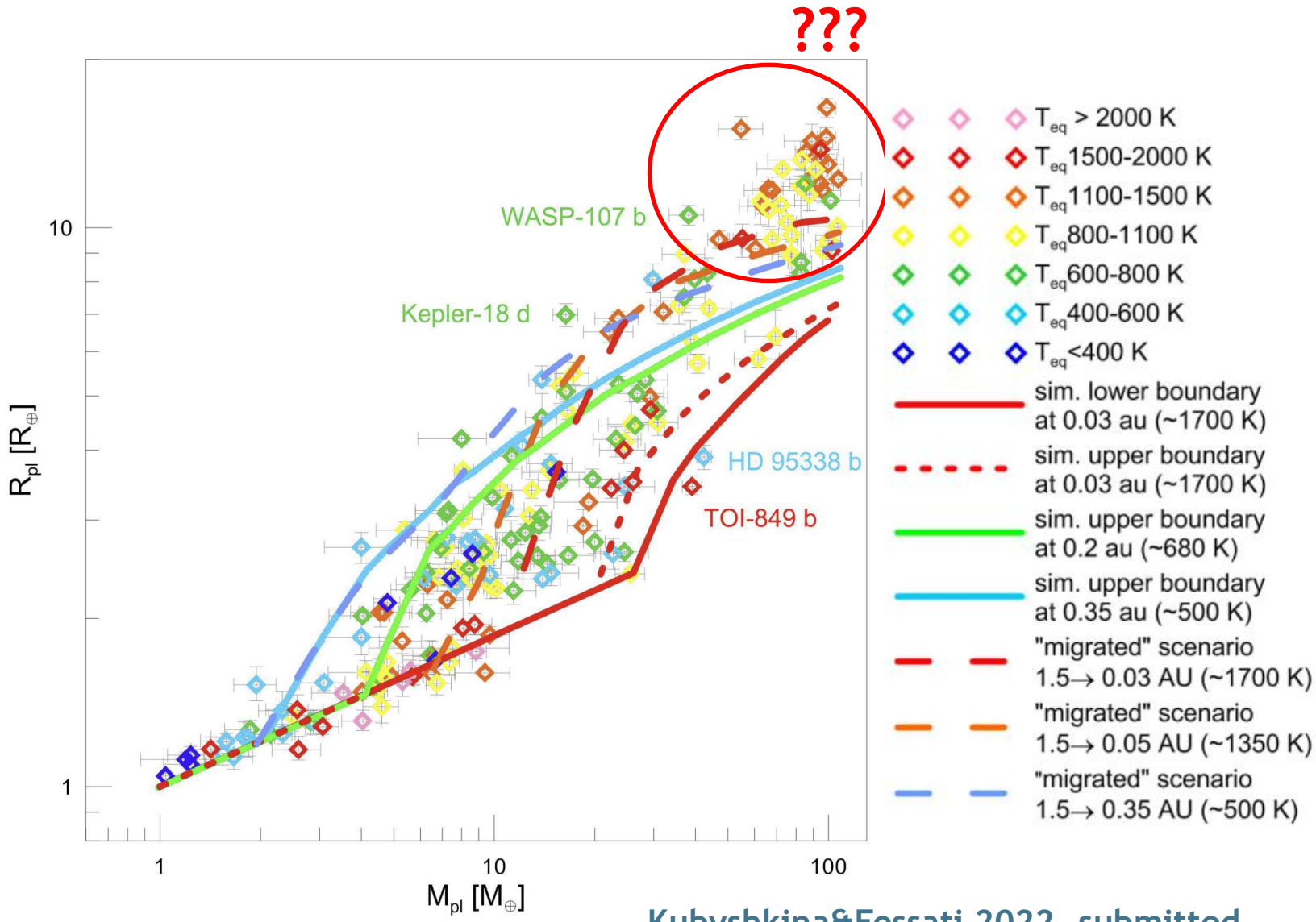
THE SPREAD FROM THE EVOLUTION MODELS





Kubyshkina&Fossati 2022, submitted

OUTLIERS: INFLATED SATURNS?



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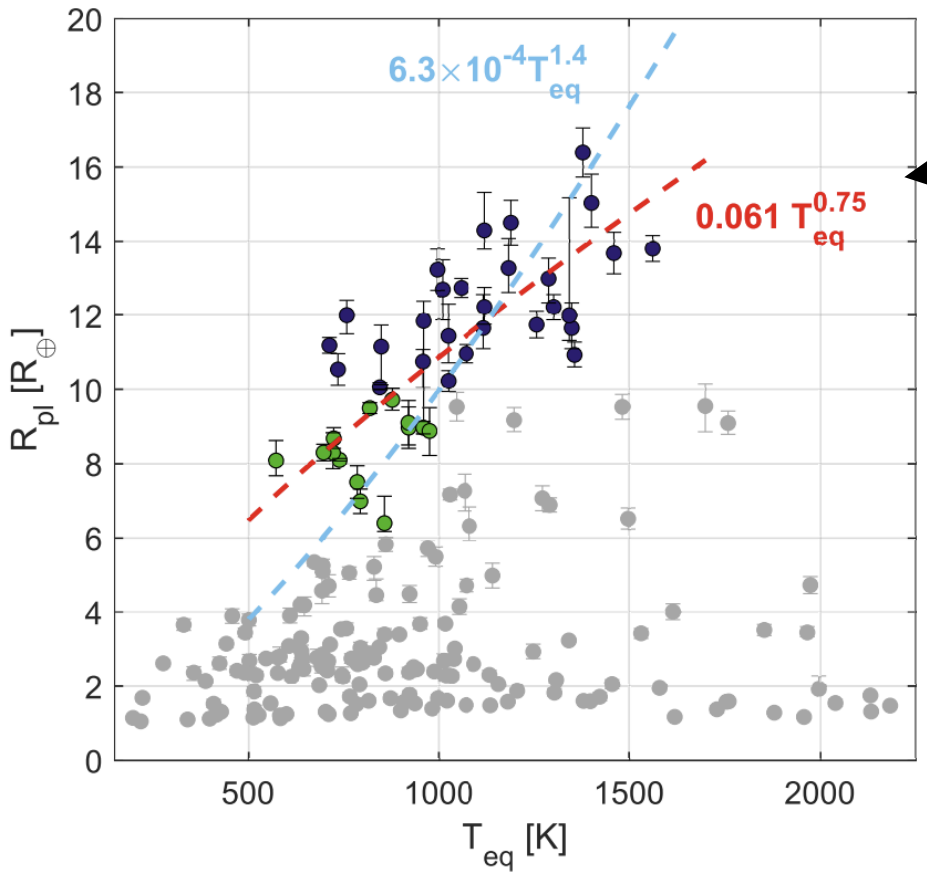

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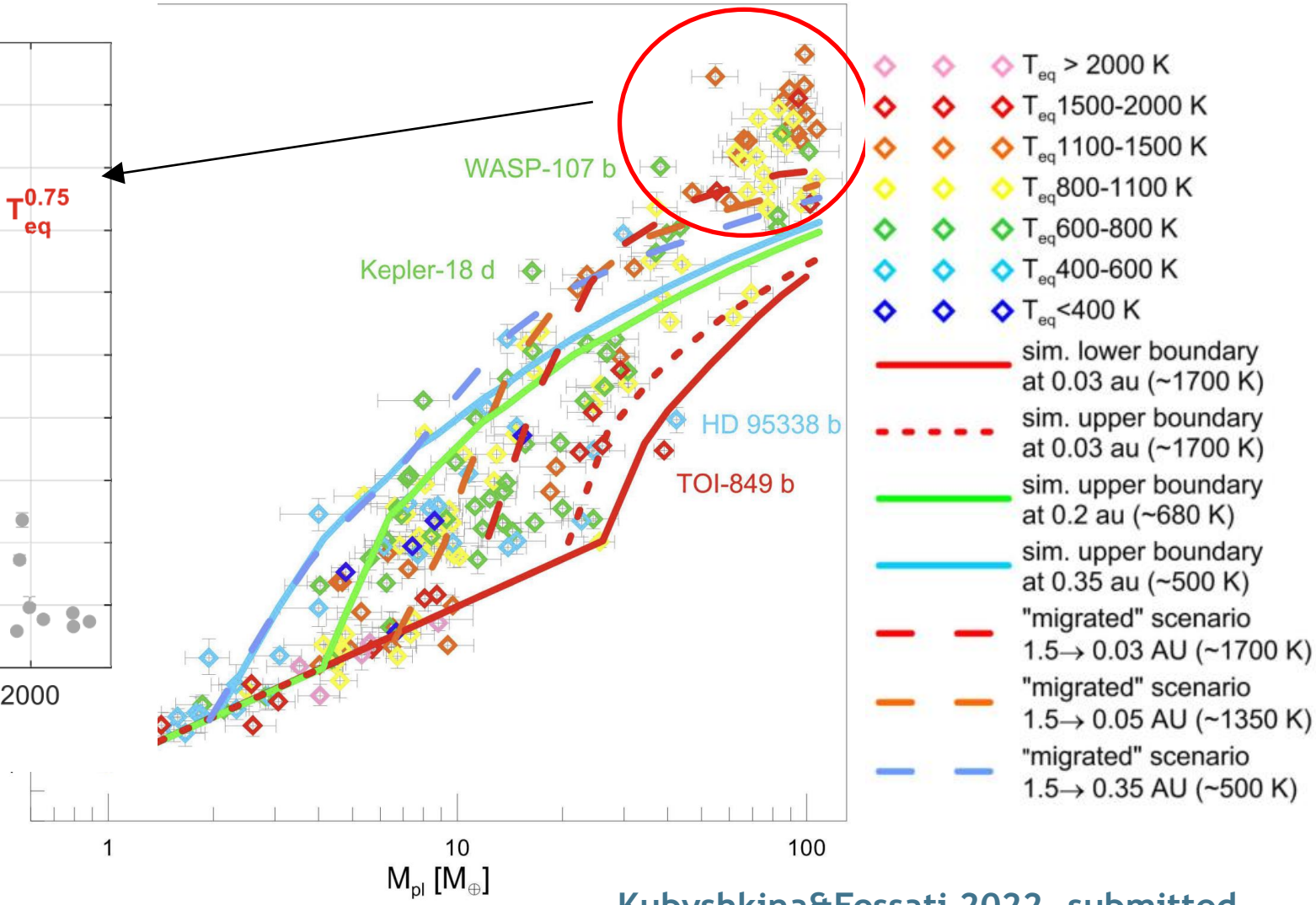

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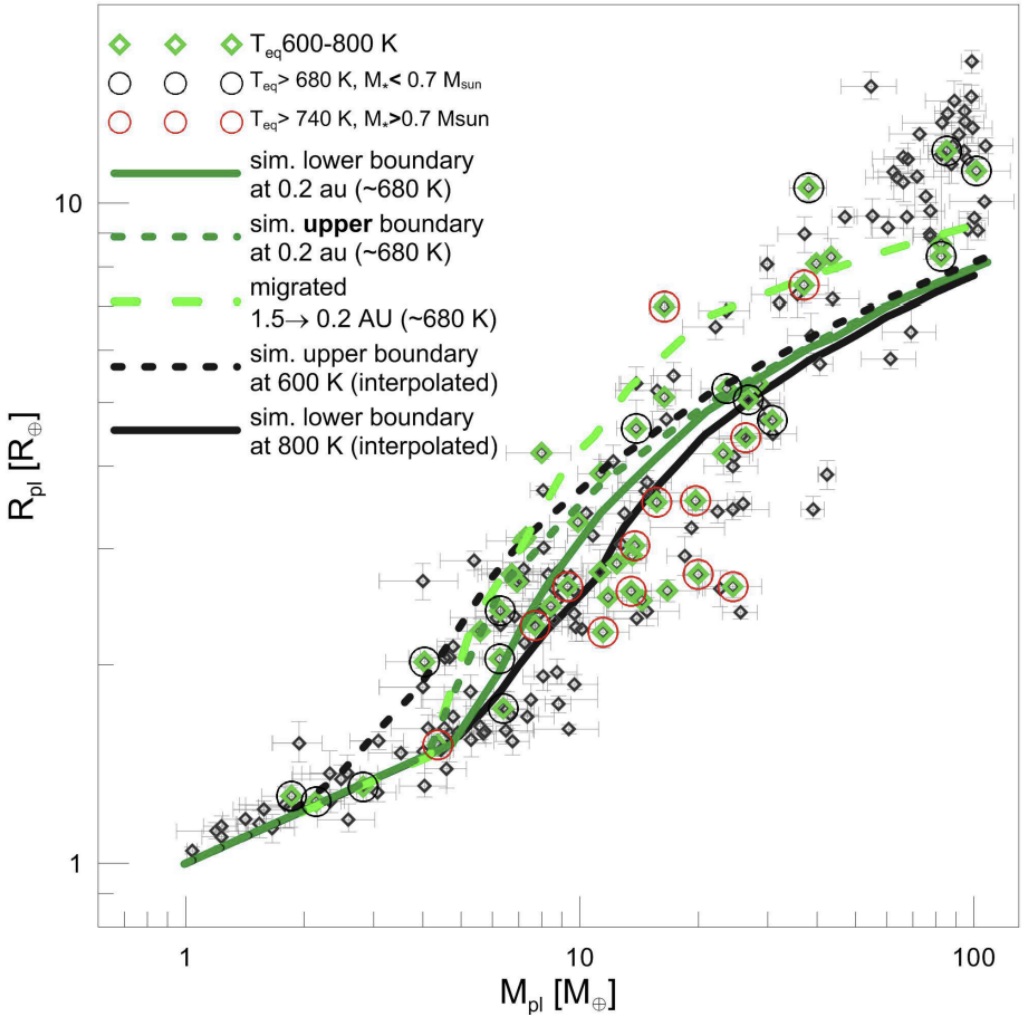
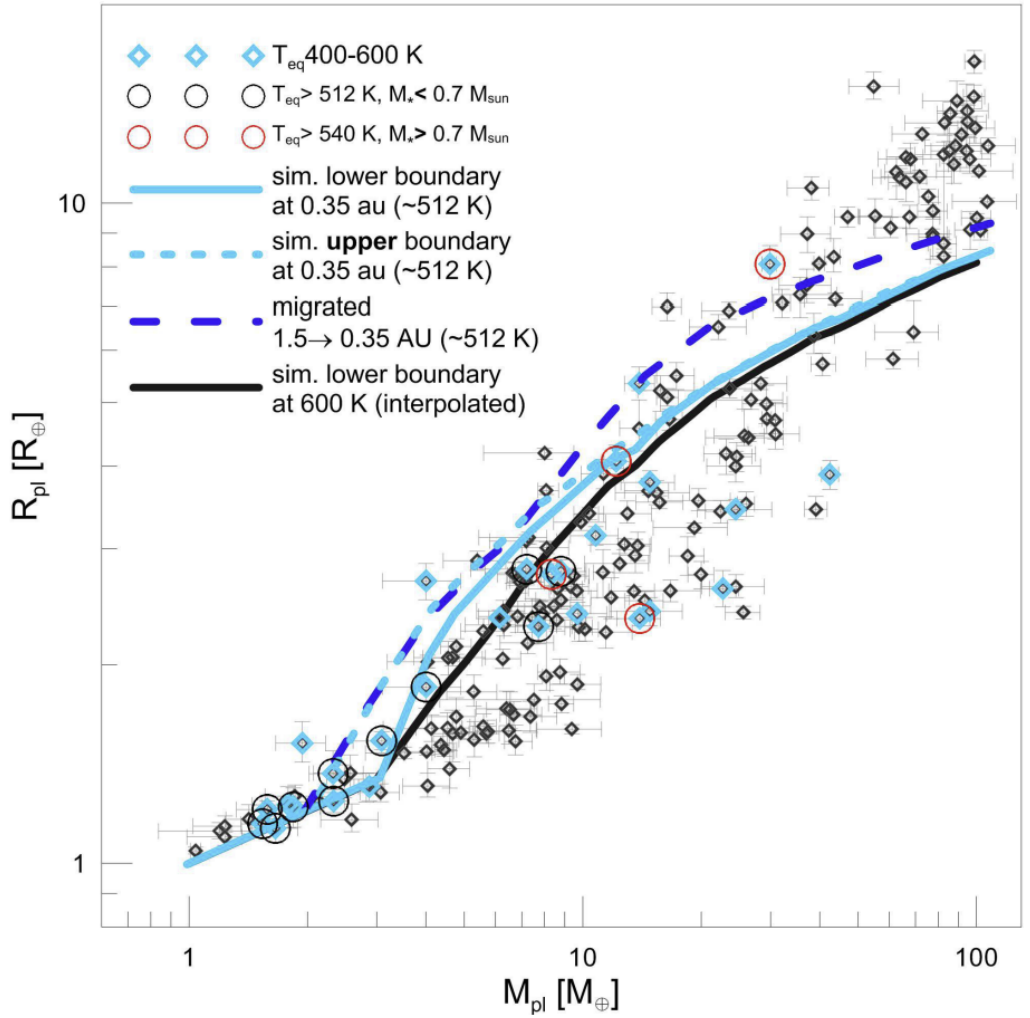
OUTLIERS: DENSE COOL NEPTUNES





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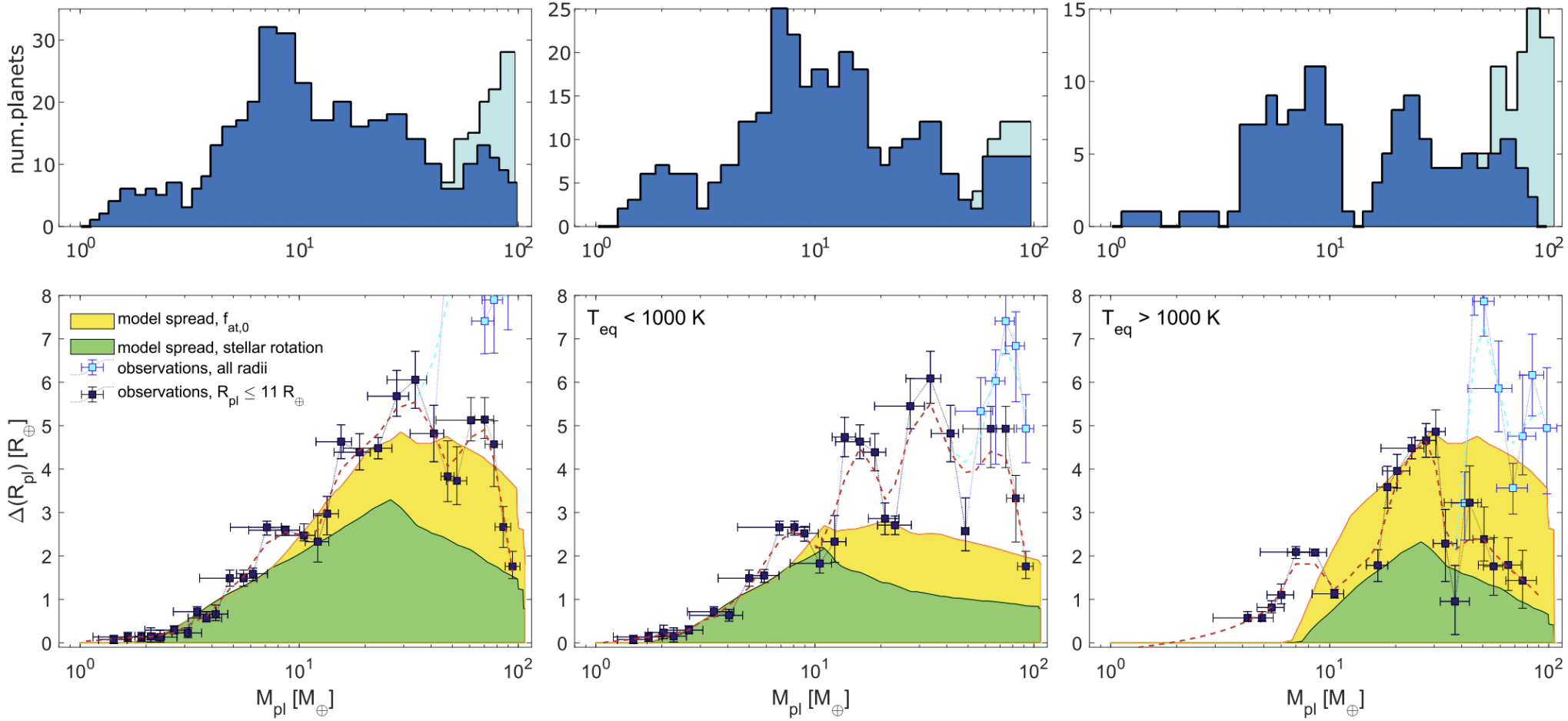
RADIUS SPREAD: MODEL VS OBSERVATIONS



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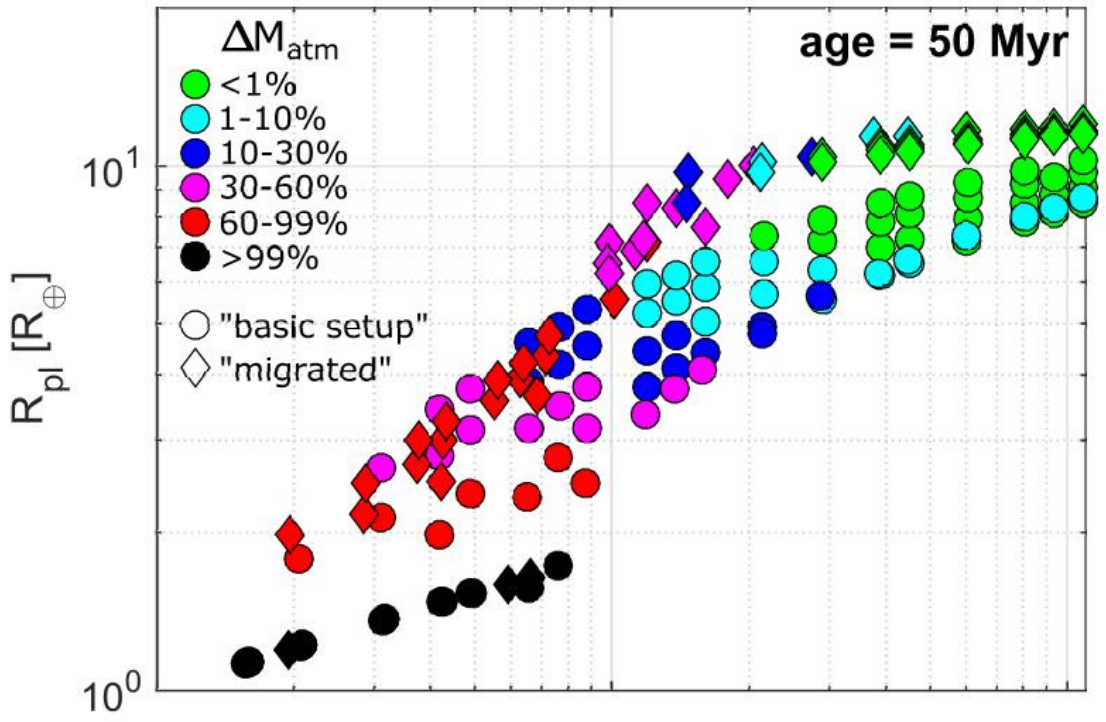
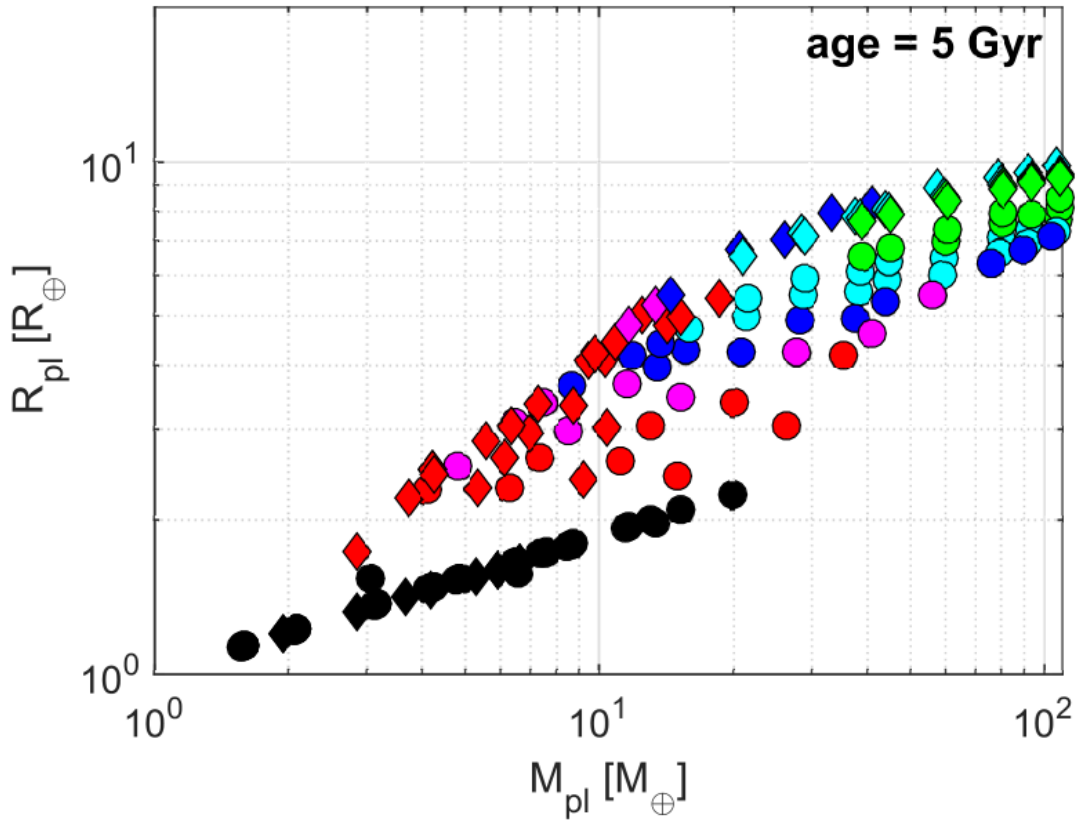
MASS-RADIUS RELATION OF THE INTERMEDIATE MASS PLANETS





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CONCLUSIONS

- The overall spread in radii is well outlined by the combination of the thermal evolution and hydrodynamic mass loss even employing a crude approximation on the initial atmospheres
- The low-mass part of the population ($<$10–20 $M_\oplus$) is shaped by the atmospheric mass loss and thus by the stellar evolution
- For intermediate mass planets, the initial atmospheres, and thus the formation mechanisms become important

- Despite the overall good agreement between our models and observations, our results show that accurate interpretation of the observed mass–radius distribution calls for advancement in the part of formation models, including the migration

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