Planet Size and Mass: Distinguishing Rocky Worlds

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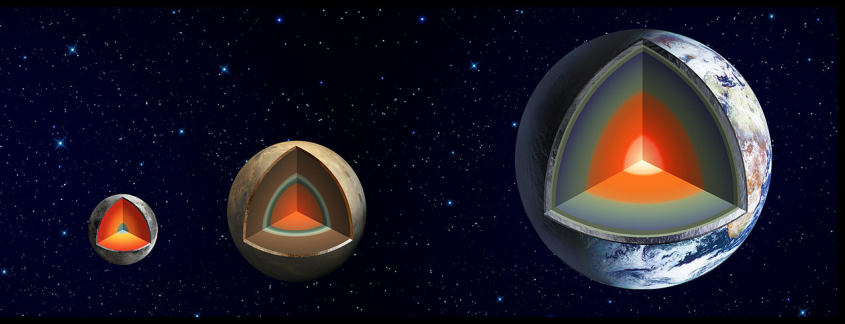
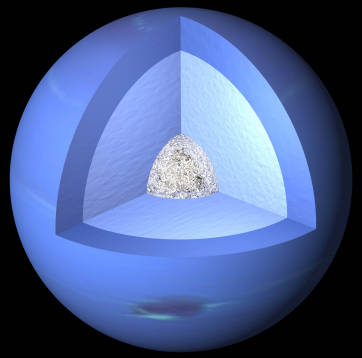
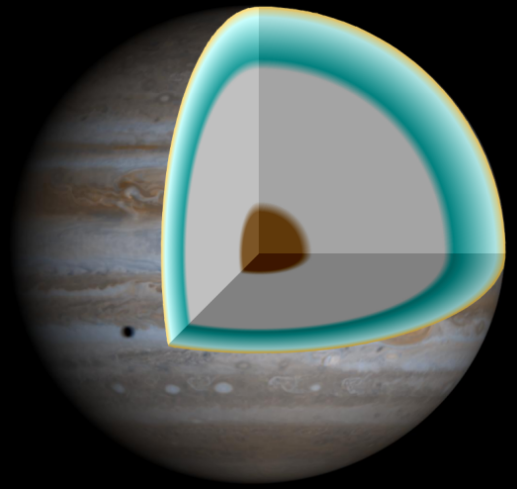
Do We Need to Measure Mass and Radius?

YES *

*Especially, if we proceed with Maggie's exploration story line

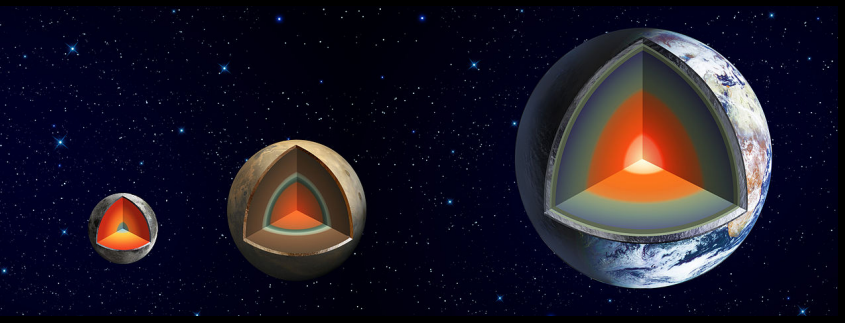


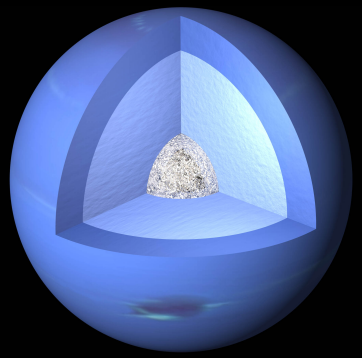


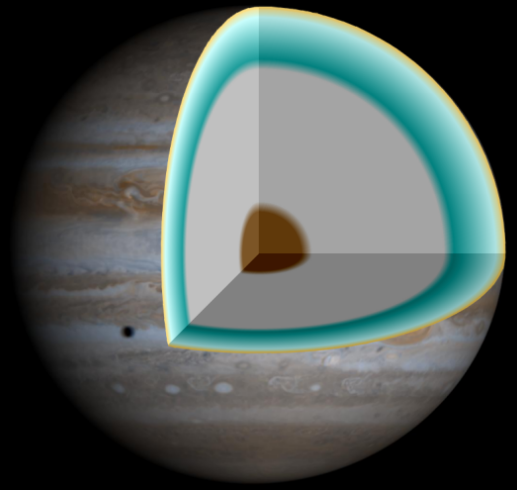


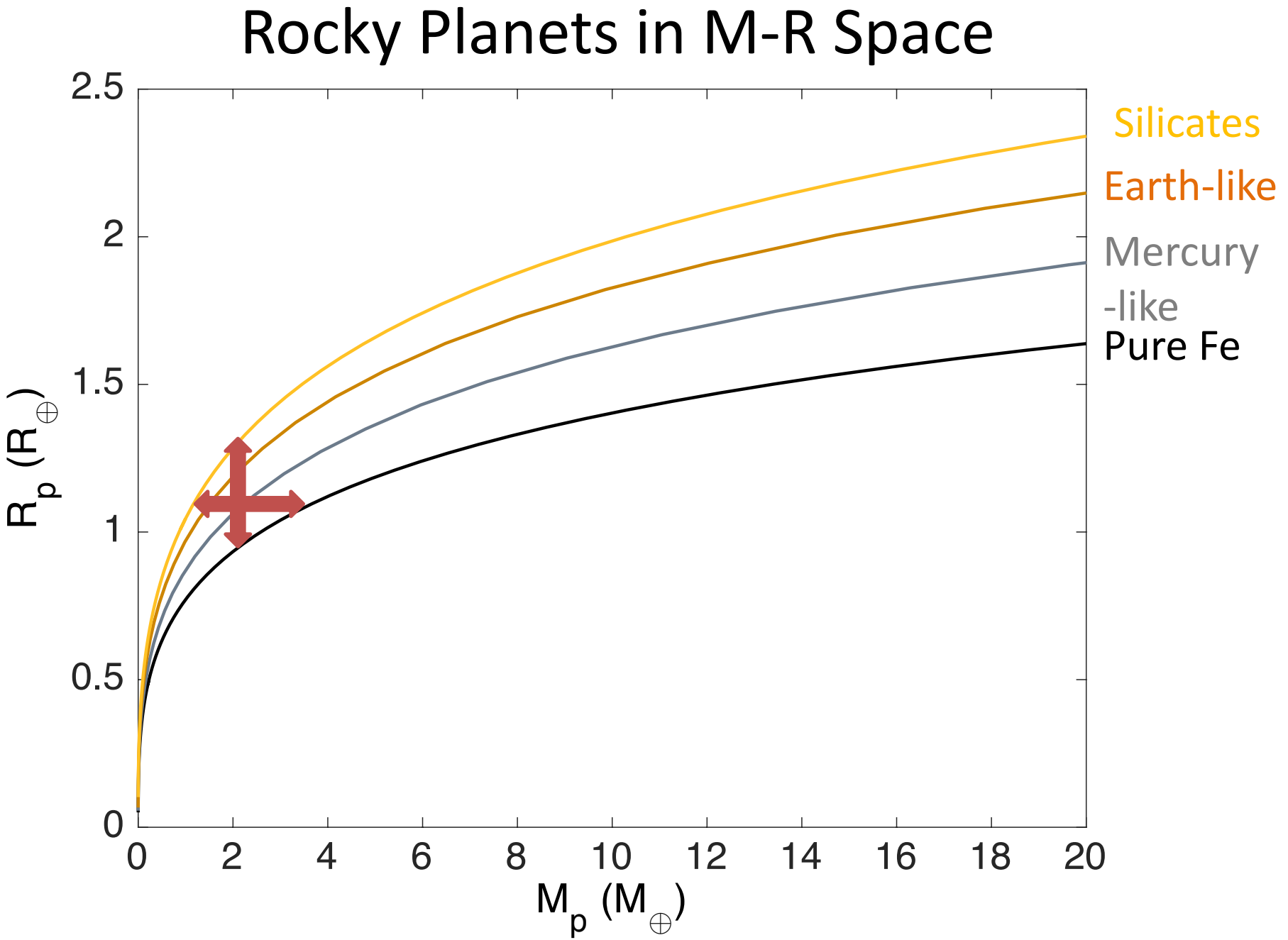
How Precisely

~~Do~~ We Need to Measure Mass and Radius?

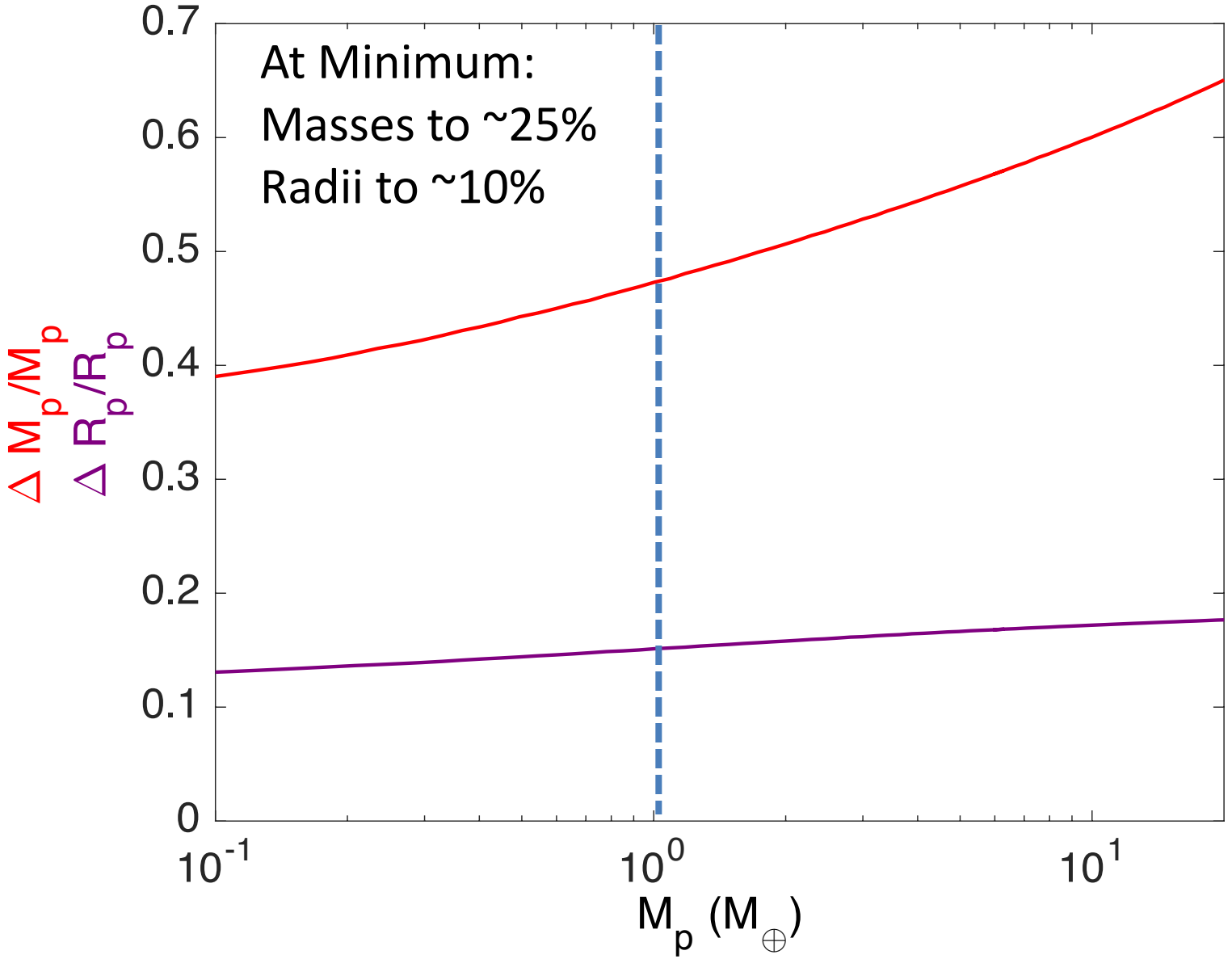







Rocky Planets in M-R Space
2.5
2
1.5
1
0.5
0
0
2
4
6
8
10
12
14
16
18
20
R_p ($R_\oplus$)
M_p ($M_\oplus$)
Silicates
Earth-like
Mercury
-like
Pure Fe

“Rule of Thumb” Baseline M-R Precision



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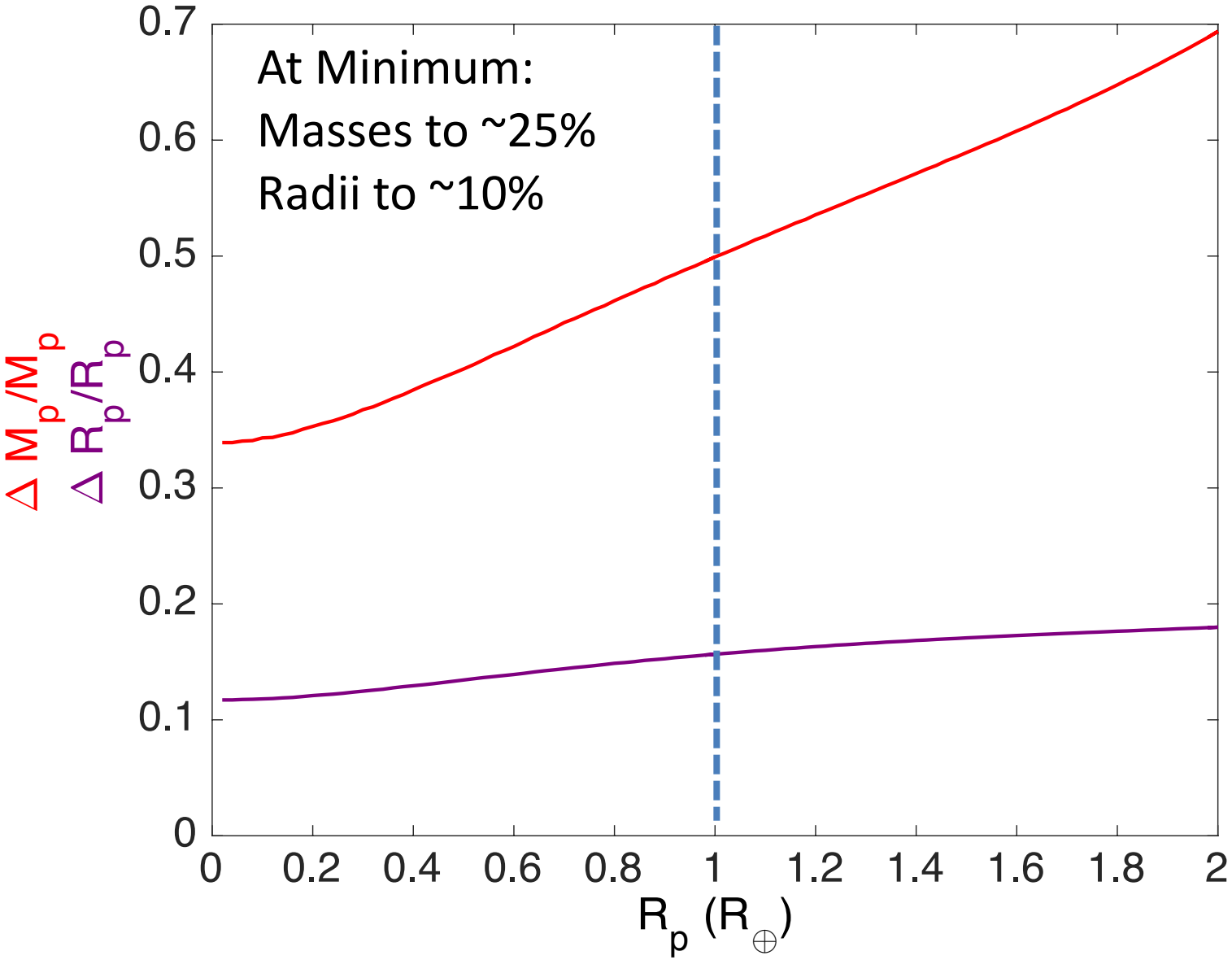

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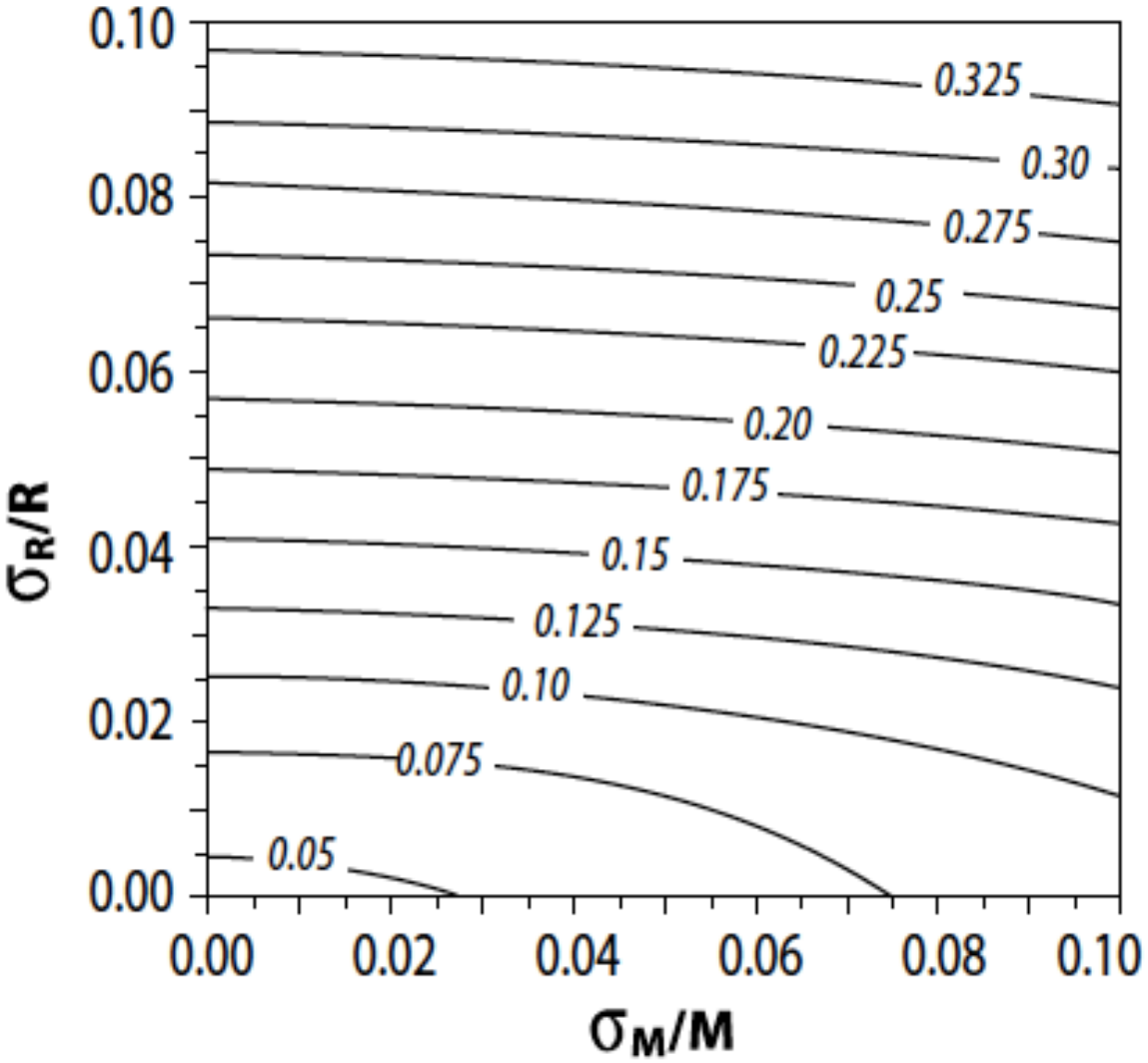

… For constraining water mass fraction.

Grasset et al. (2009)

How Precisely

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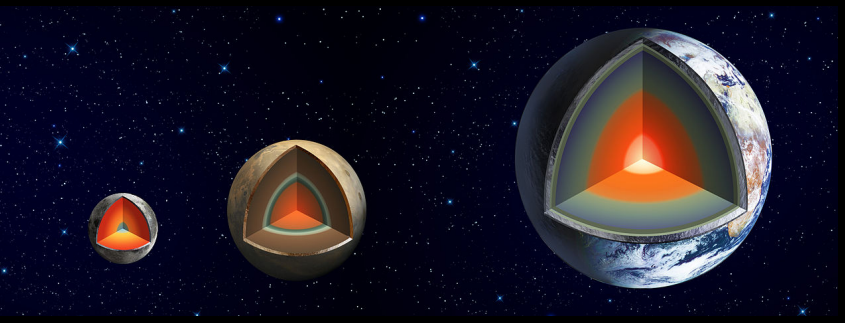
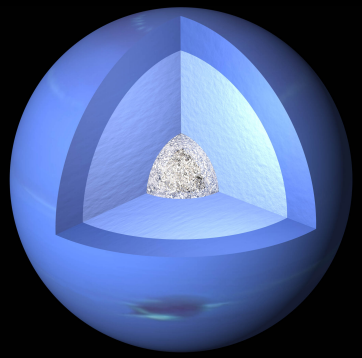
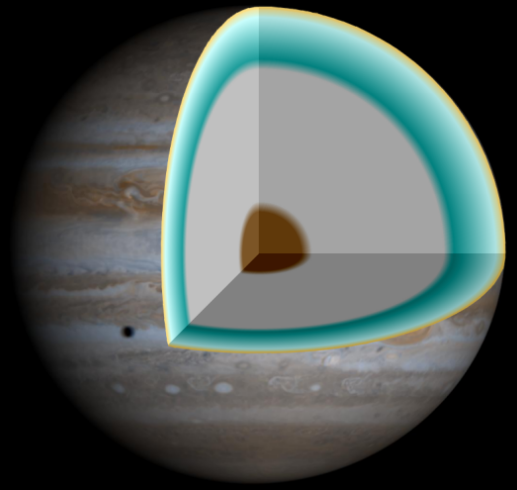
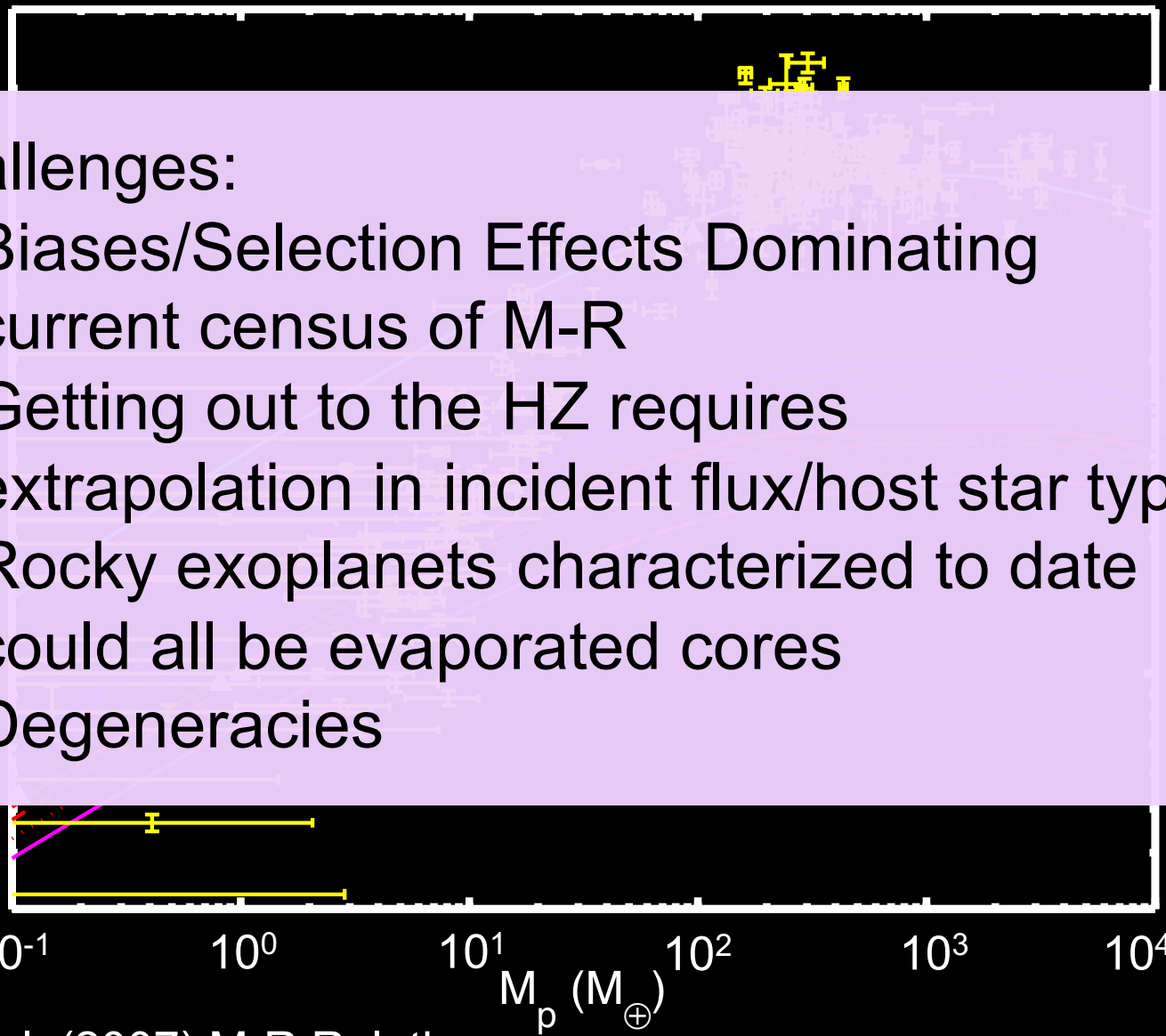
Beyond rough rules of thumb







Use Full Population of Planets to Inform Priors

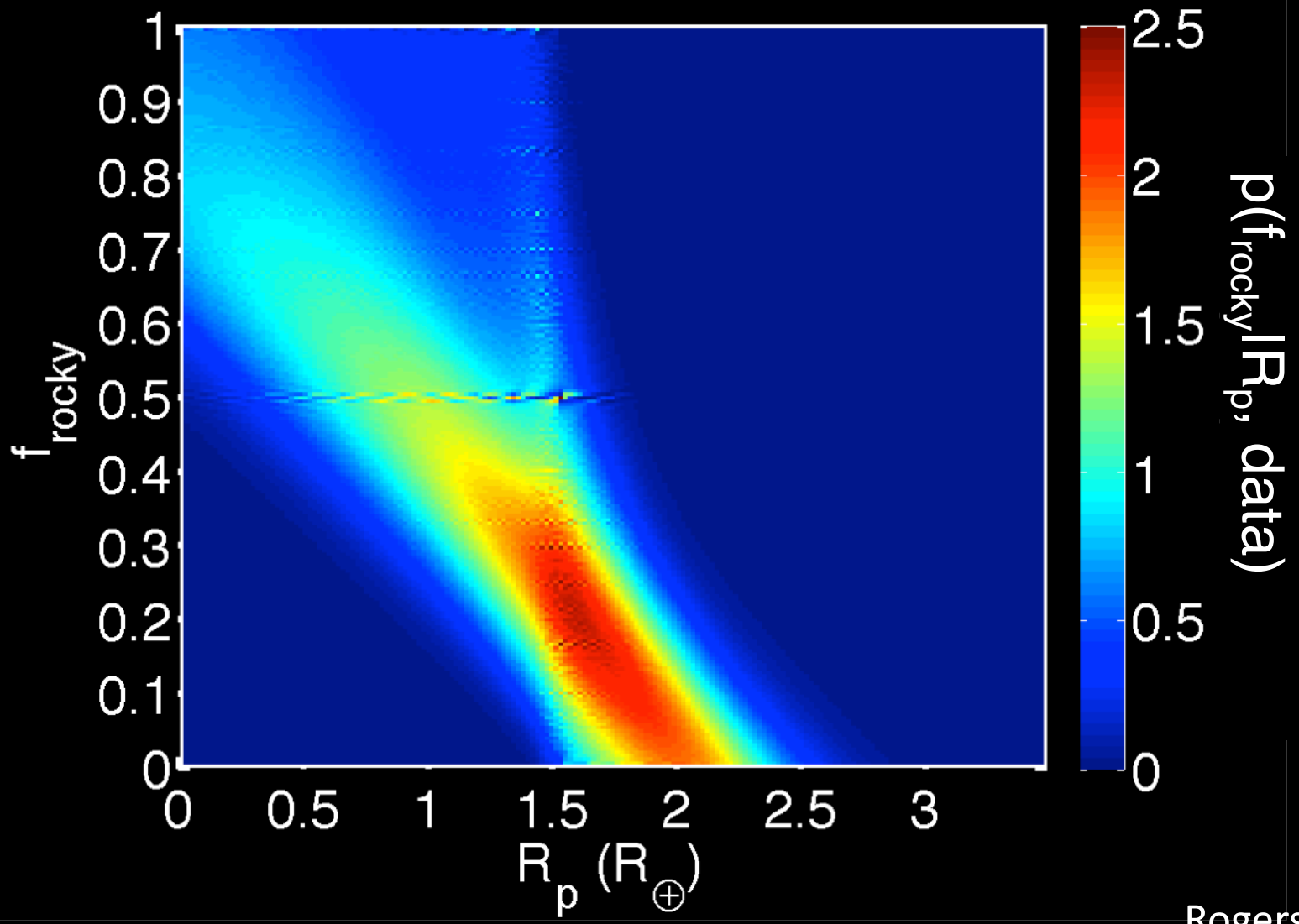


Challenges:

- Biases/Selection Effects Dominating current census of M-R
- Getting out to the HZ requires extrapolation in incident flux/host star type
- Rocky exoplanets characterized to date could all be evaporated cores
- Degeneracies

Seager et al. (2007) M-R Relations

Linear Transition Model: Posterior Distribution for $f_{rocky}(R_p)$



Rogers (2015)

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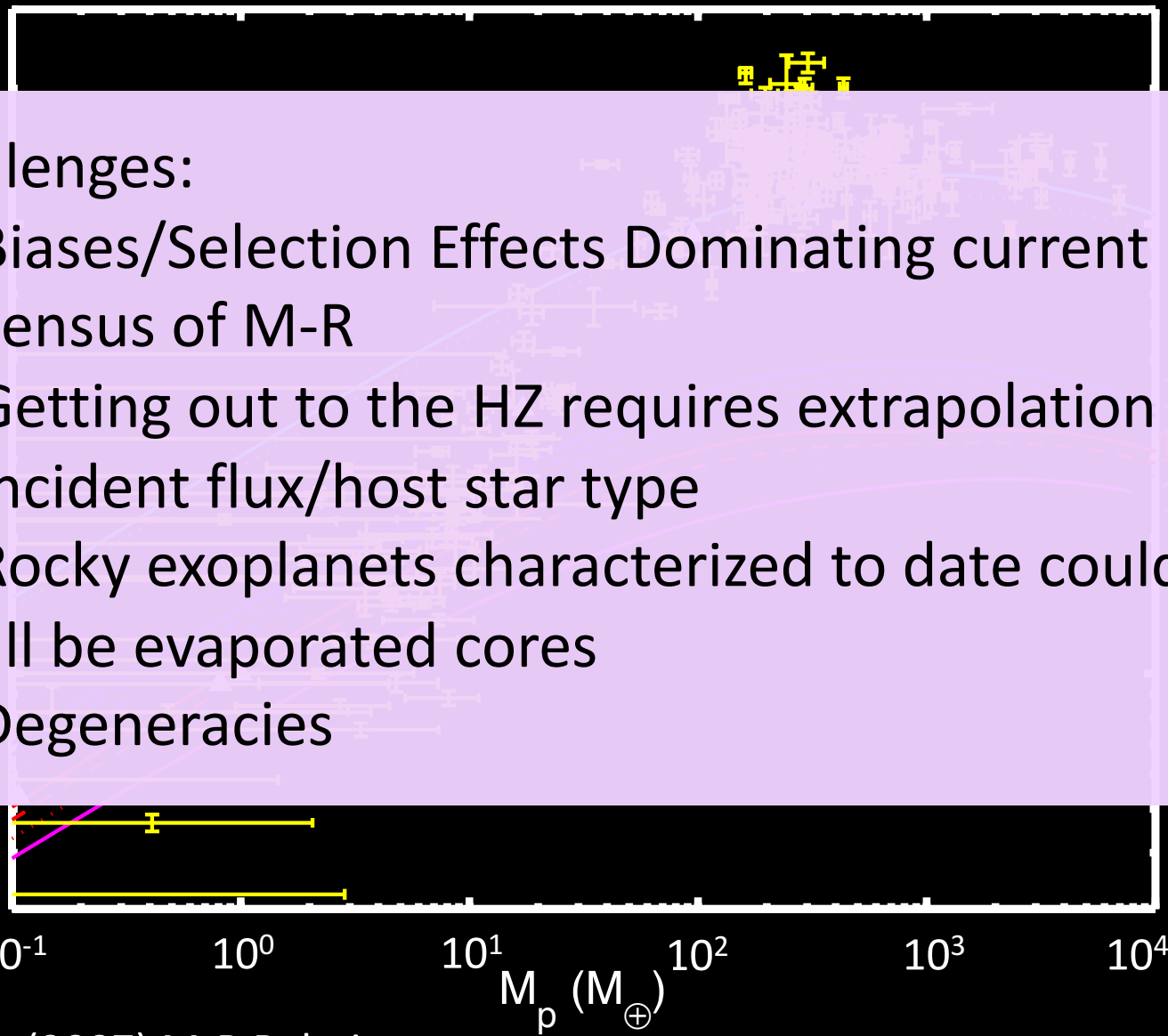

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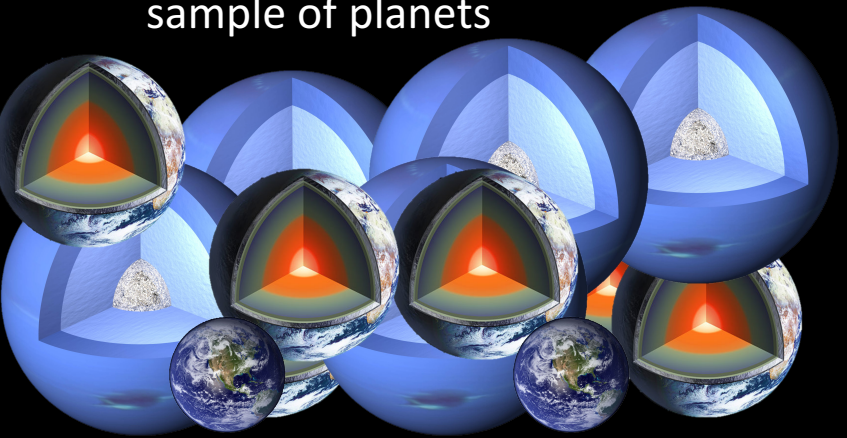
How well can we hope to constrain the planet composition distribution?

Input Parameters

Parameterized Model of Planet Mass-Composition Distribution

Generate simulated sample of planets



Add Noise

Simulated

$M_p + R_p + F_p$

Measurements

Apply Hierarchical analysis using

Output Parameters

Parameterized Model of Planet Mass-Composition Distribution

Rogers et al. in prep.

Main Takeaway Points

- Baseline Rule of Thumb: need to measure masses to $\sigma_M/M < 25\%$ and $\sigma_R/R < 10\%$ to help discriminate rocky/non-rocky.
- Of course, constraints on planet composition improve with improving precision.
- Moving forward, will leverage census of accumulating M-R measurements to inform interpretation.