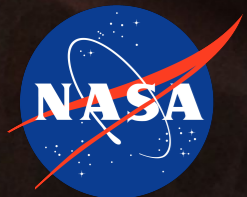


# A Southern Hemisphere RV Follow-up Program for TESS with PFS/Magellan



Thanks NASA!

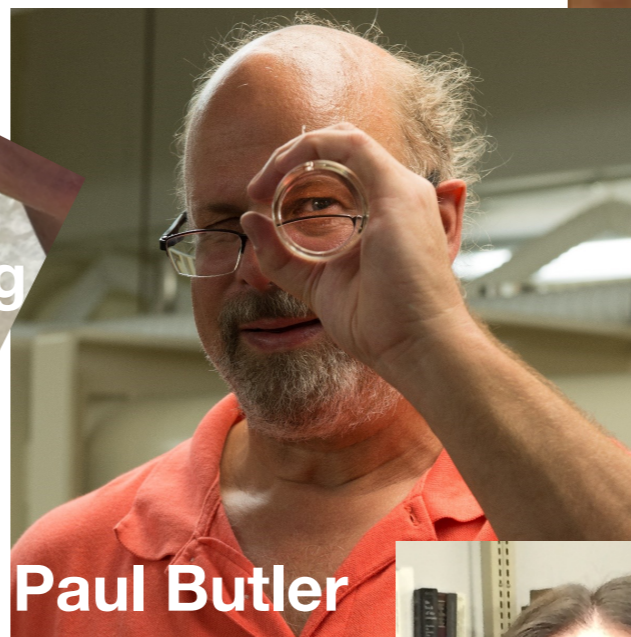
Johanna Teske  
Carnegie Observatories



**Steve Shectman**



**Sharon  
Xuesong  
Wang**



**Paul Butler**



**Angie  
Wolfgang**



**Ward Howard**



**Jeff Crane**



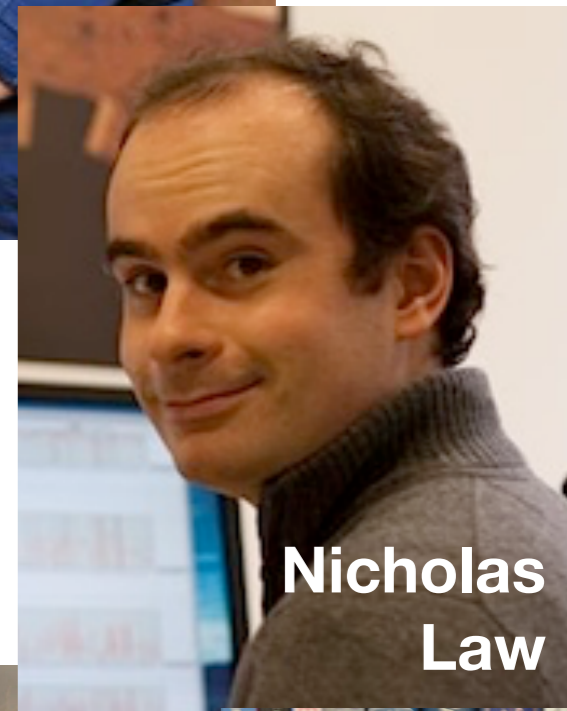
**Ian  
Thompson**



**Fabo  
Feng**



**Alycia  
Weinberger**

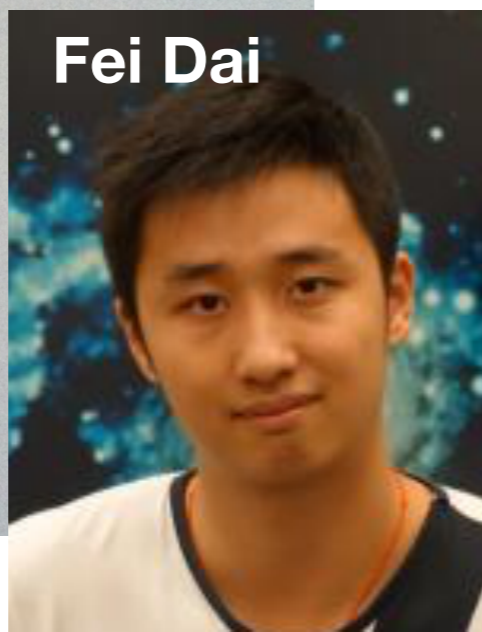


**Nicholas  
Law**



CLAY 6.5 METER

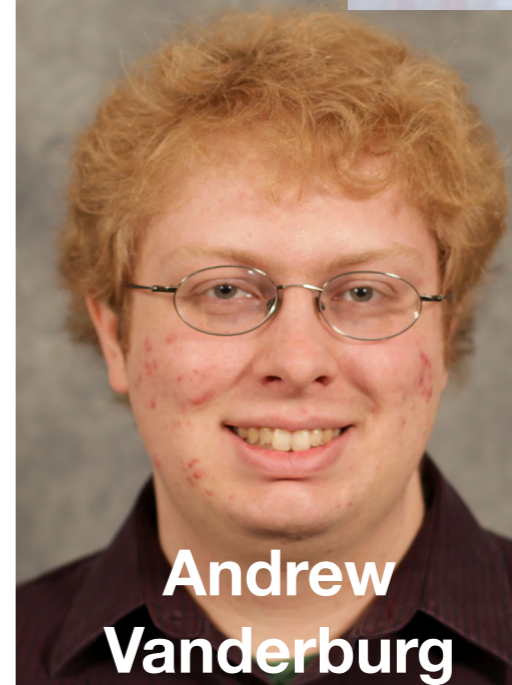
**Jennifer Burt**



**Fei Dai**



**Avi Shporer**



**Andrew  
Vanderburg**



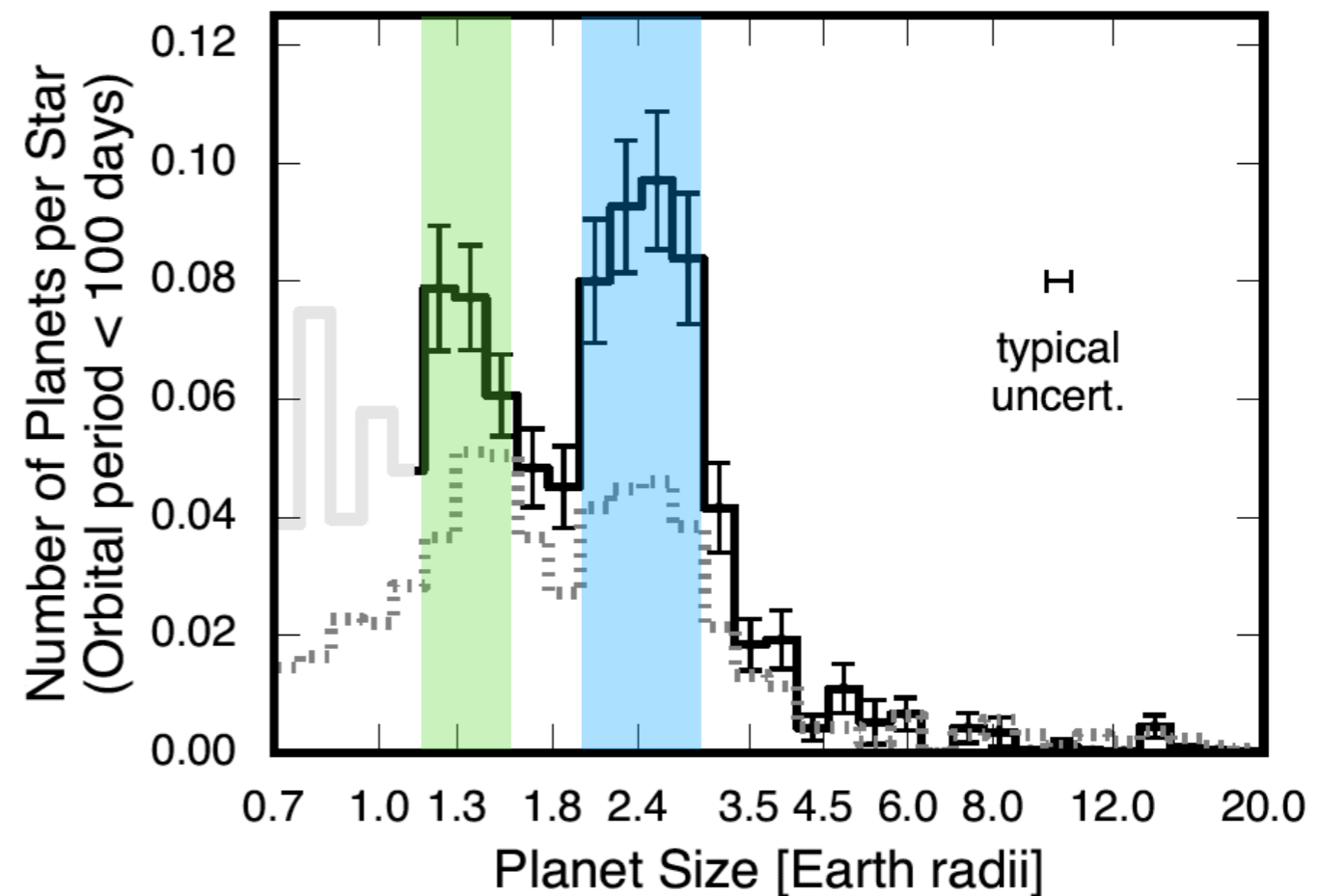
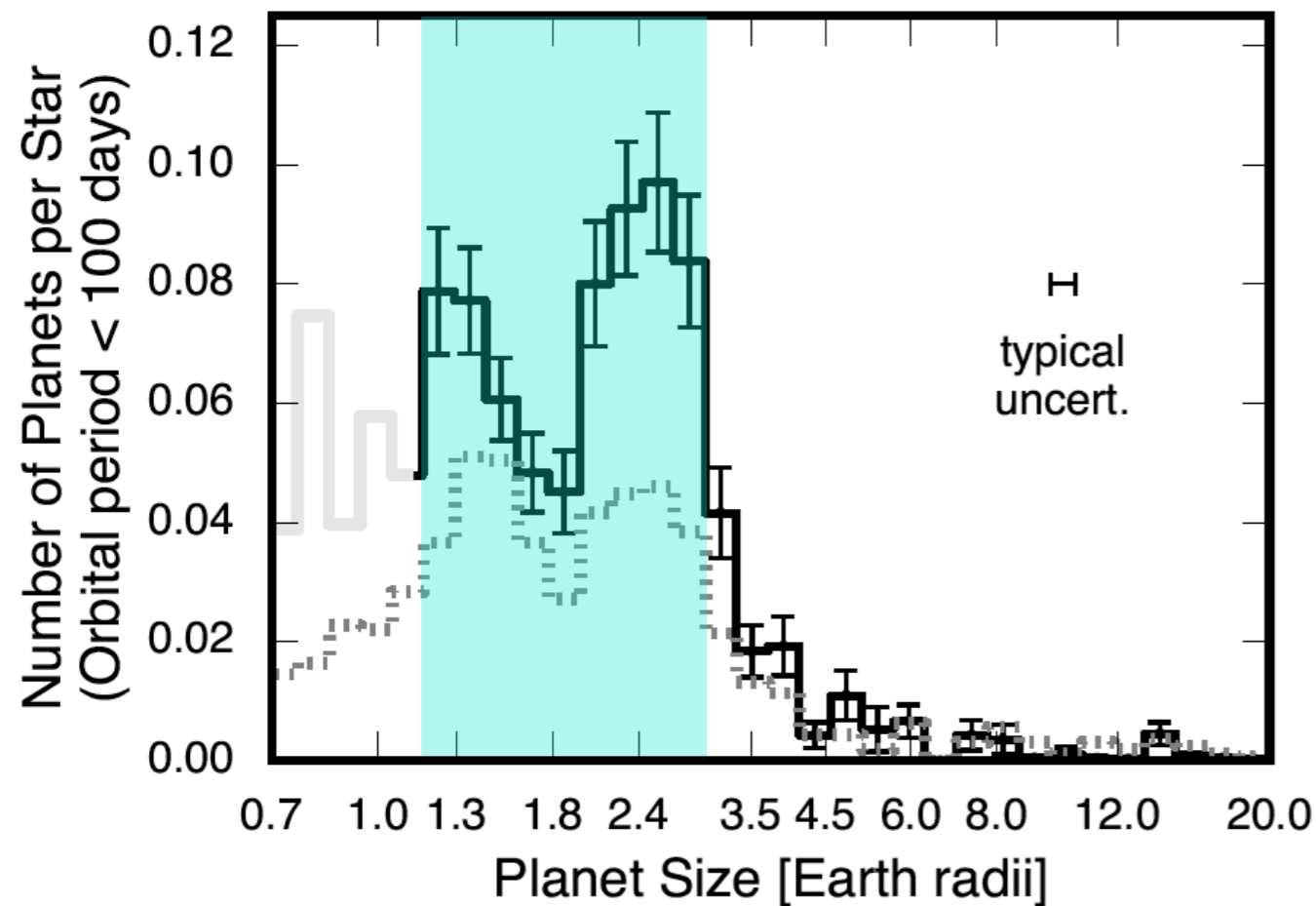
**Raphaëlle  
Haywood**

# Do super-Earths and sub-Neptunes...

**form in a similar way and get influenced by post-formation processes?**

**form differently from the start (and also get altered after formation)?**

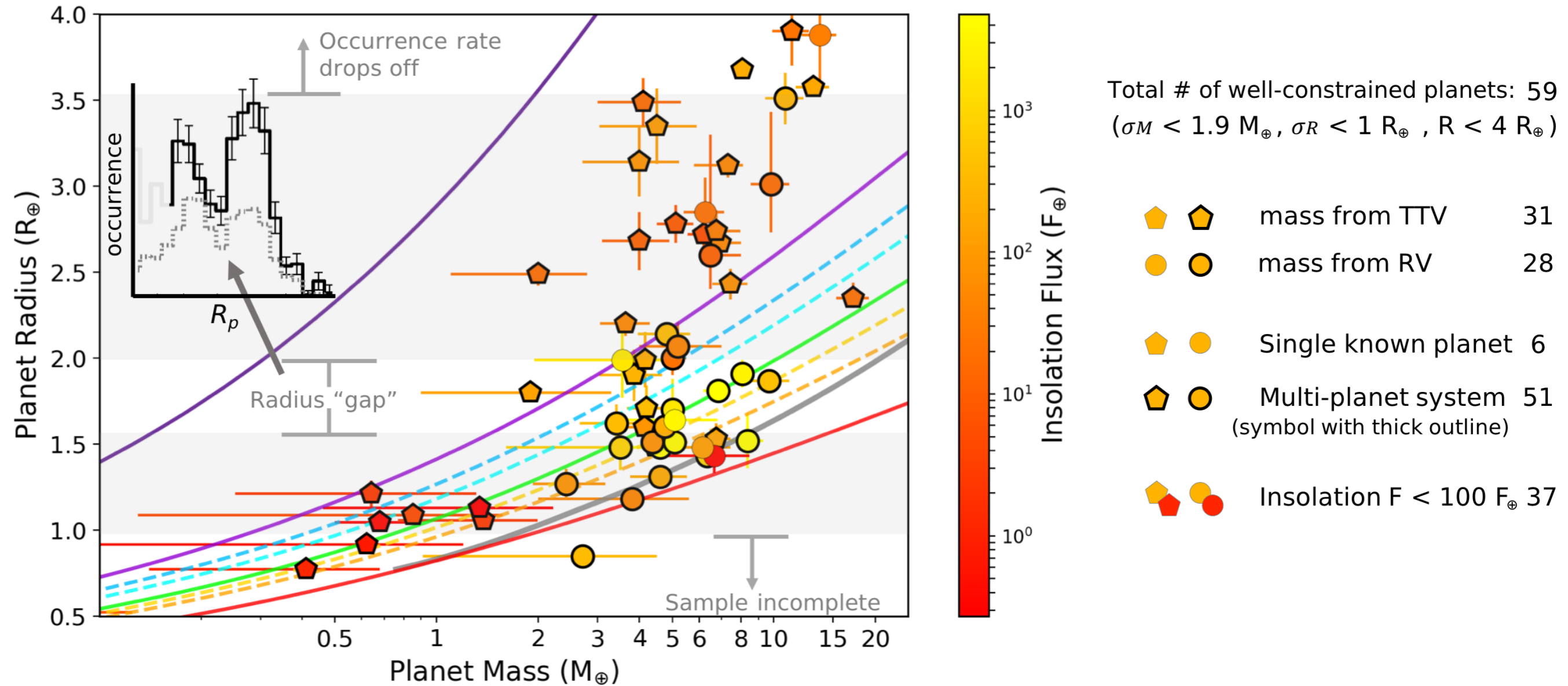
*Lopez & Rice 16*



*Fulton & Petigura 18*

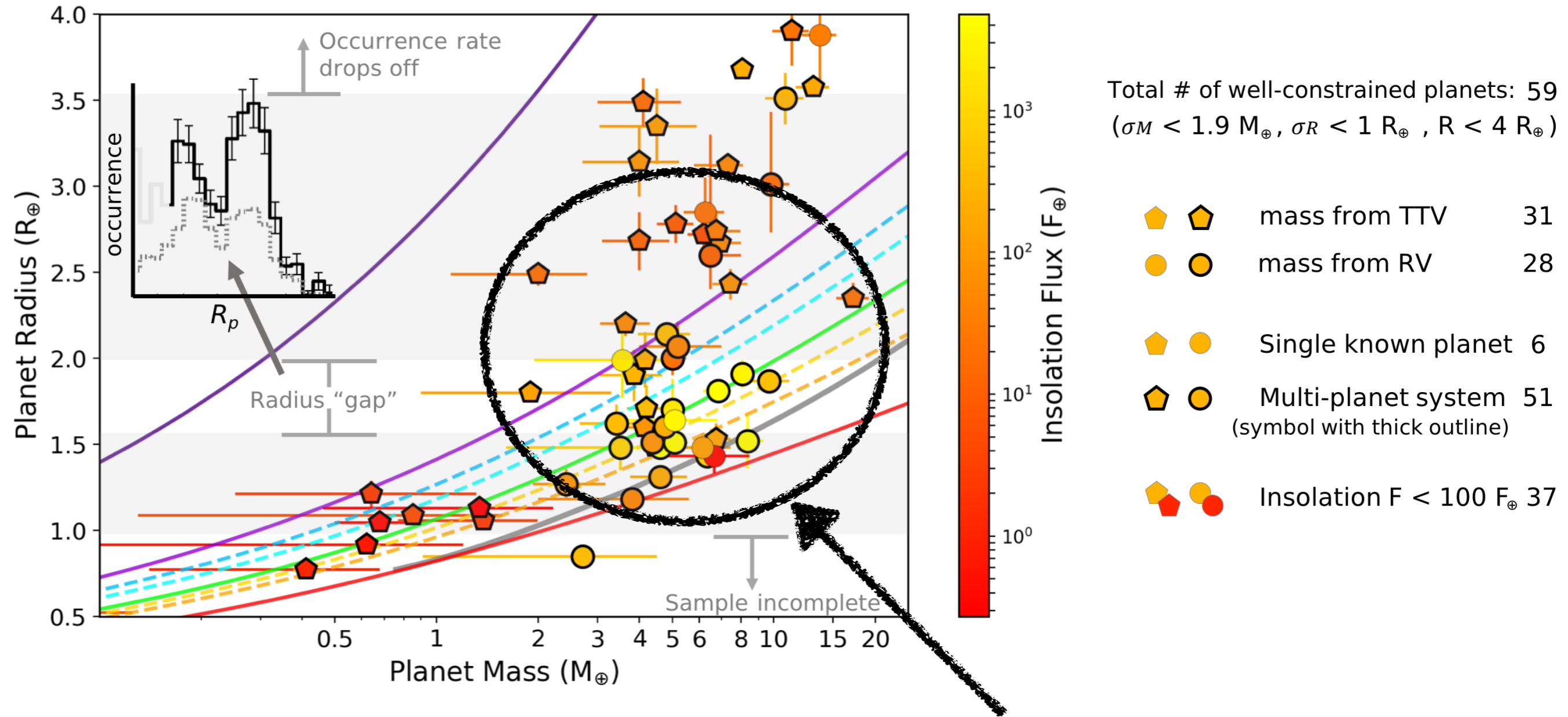
# Why should you care?

## Landscape of Small Planets circa Oct. 2018



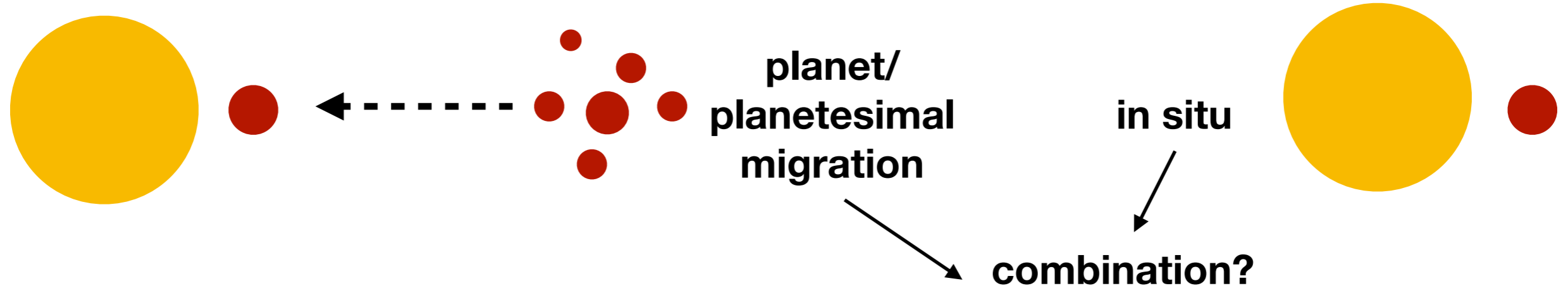
# Why should you care?

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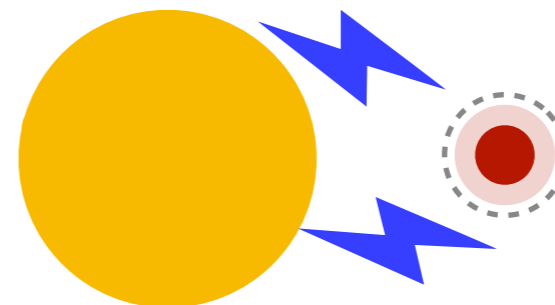
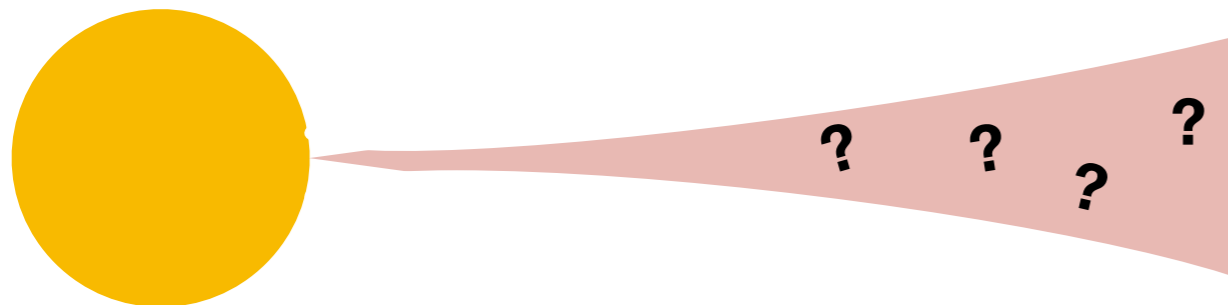


**What's up with these?!**

From the theoretical perspective, it remains unclear whether the combination of different formation scenarios and post-formation processes is consistent with one or multiple small planet populations.



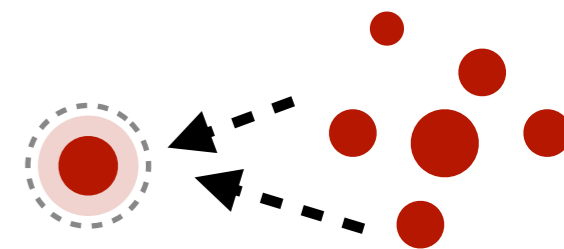
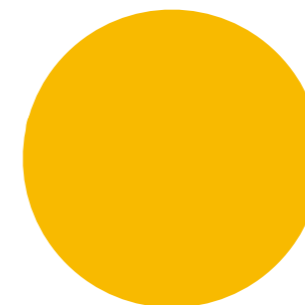
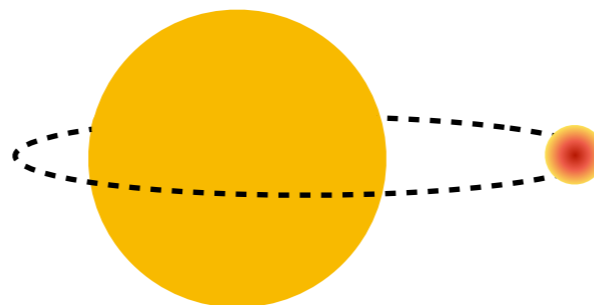
variation in disk masses, lifetimes, local temperatures, opacities



photoevaporation from high energy stellar radiation

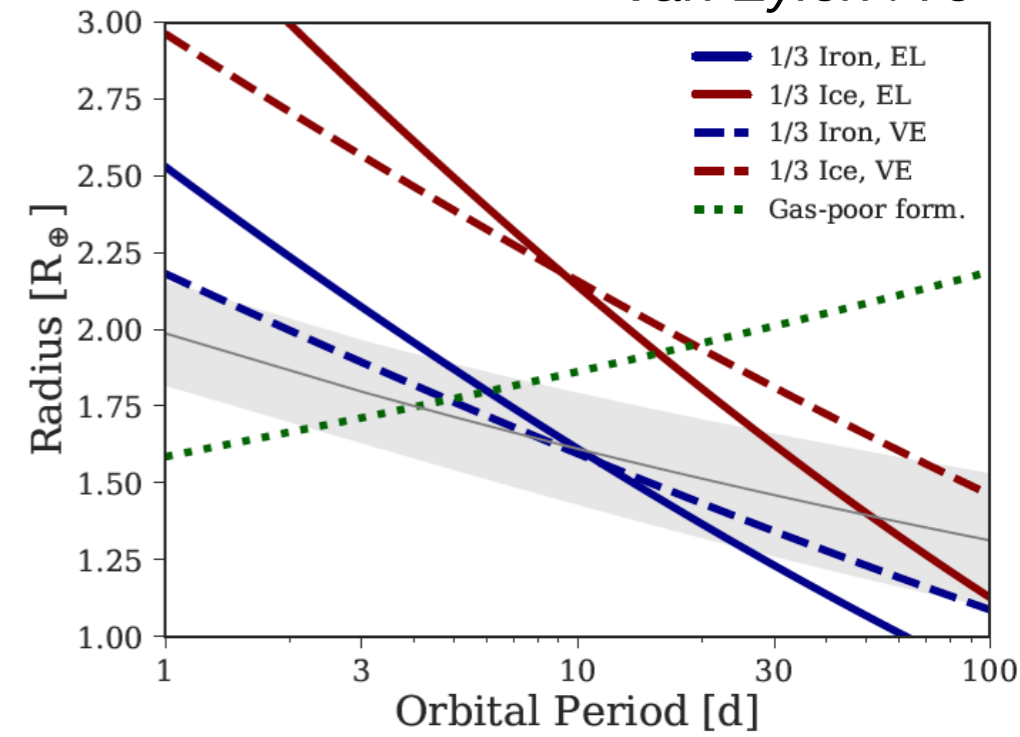
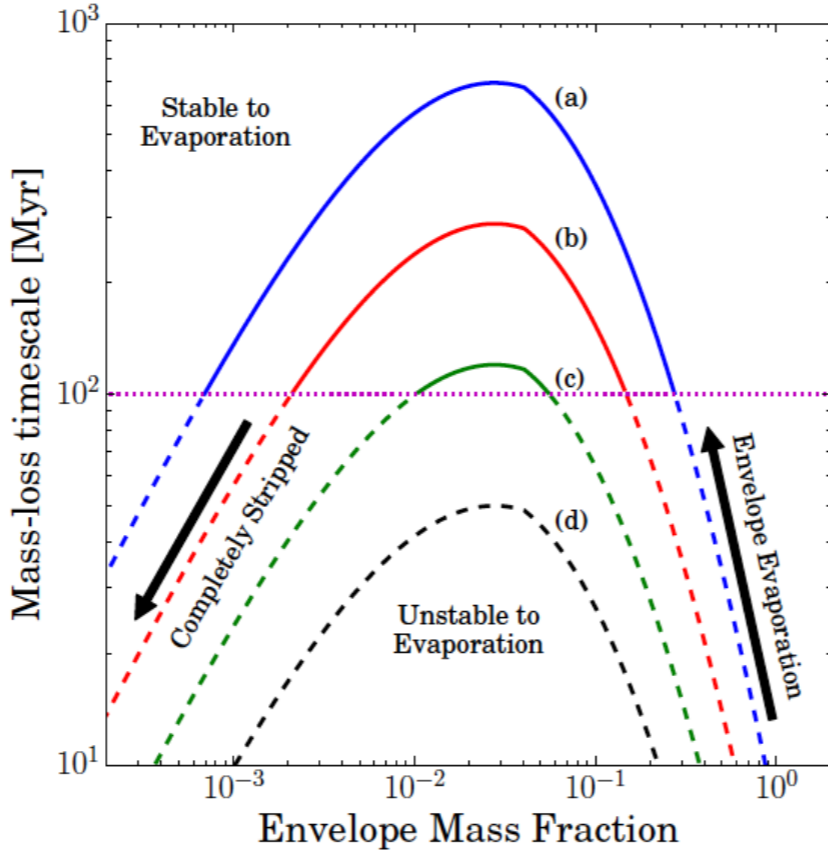
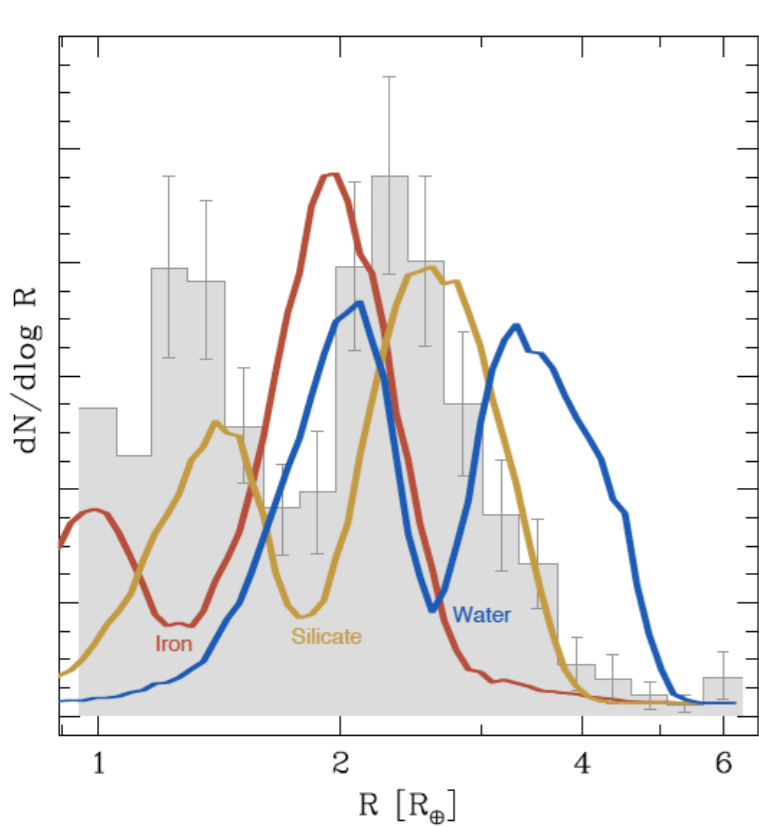
giant or planetesimal impacts

tidal heating, slowing cooling and continued accretion



From the observational perspective, evidence is mounting for similar formation+post-processing creating the observed distribution.

Van Eylen+18

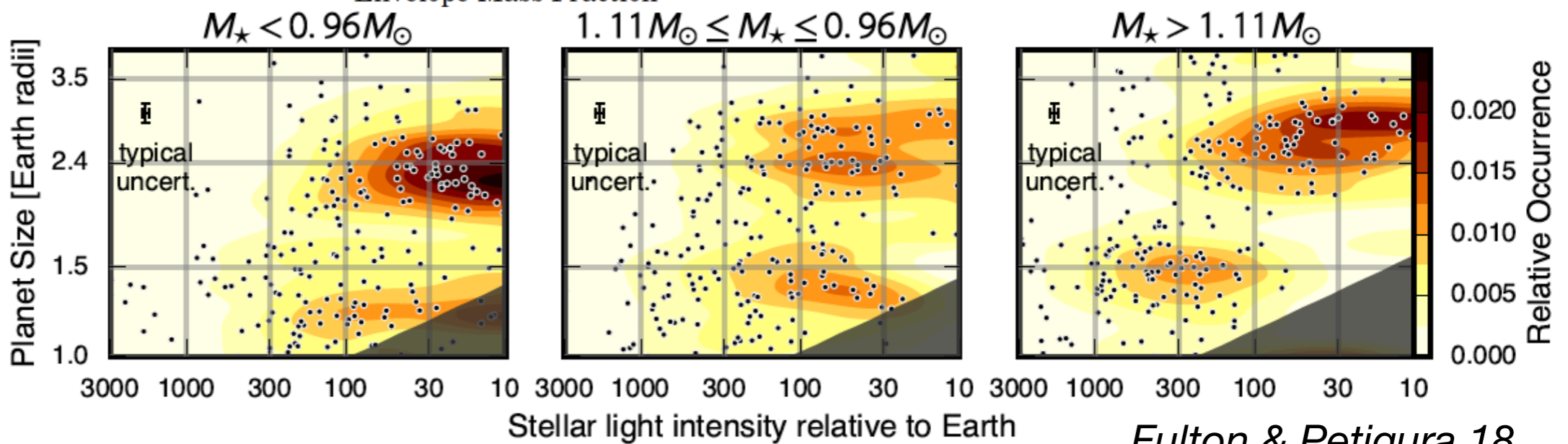


asteroseismology+fit to  $R-P$  consistent with photovap

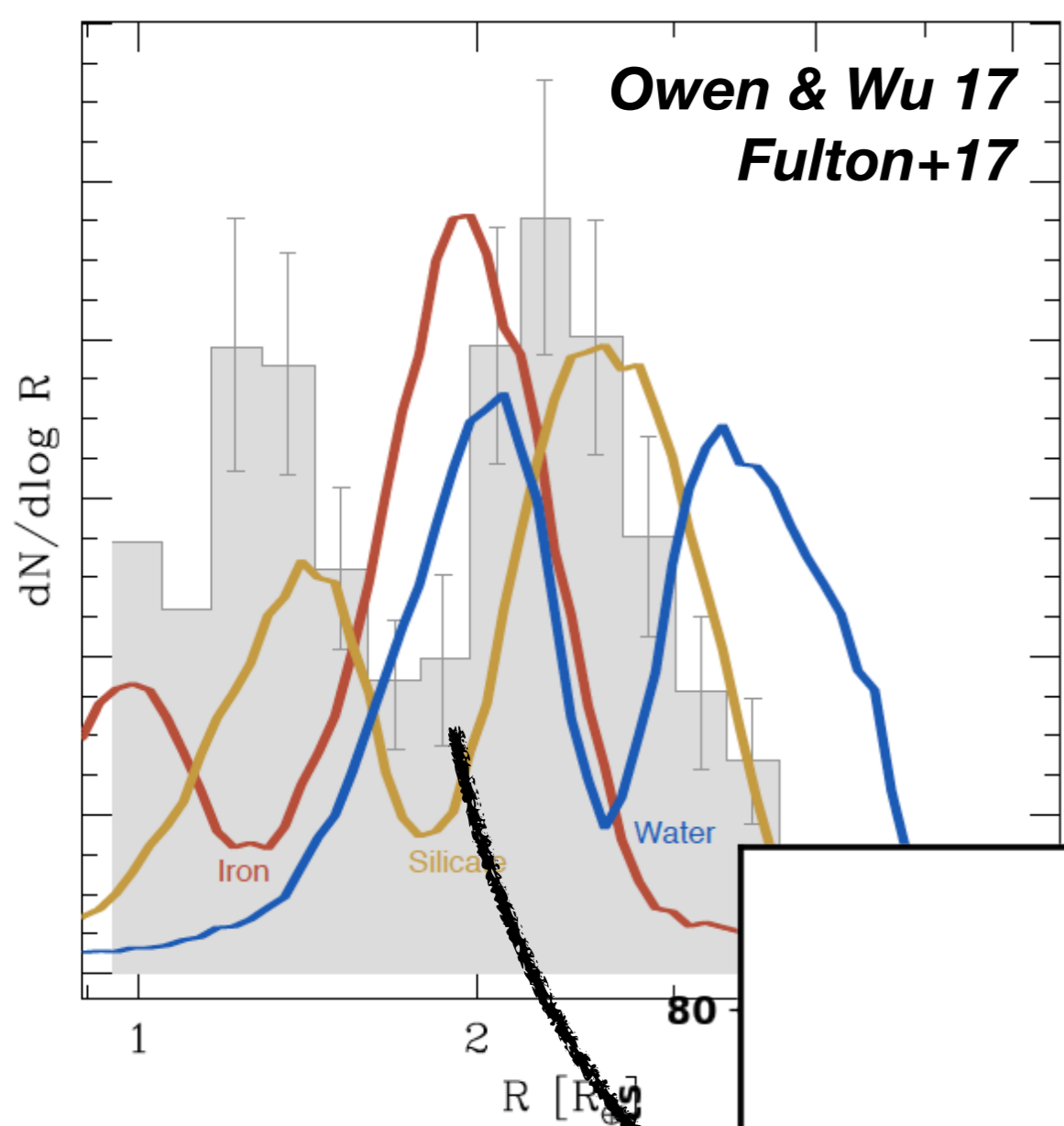
analytic photoevap theory+ pop synthesis matches Fulton+17

Owen & Wu 17

trends with stellar mass and insolation flux favor photoevap



Fulton & Petigura 18

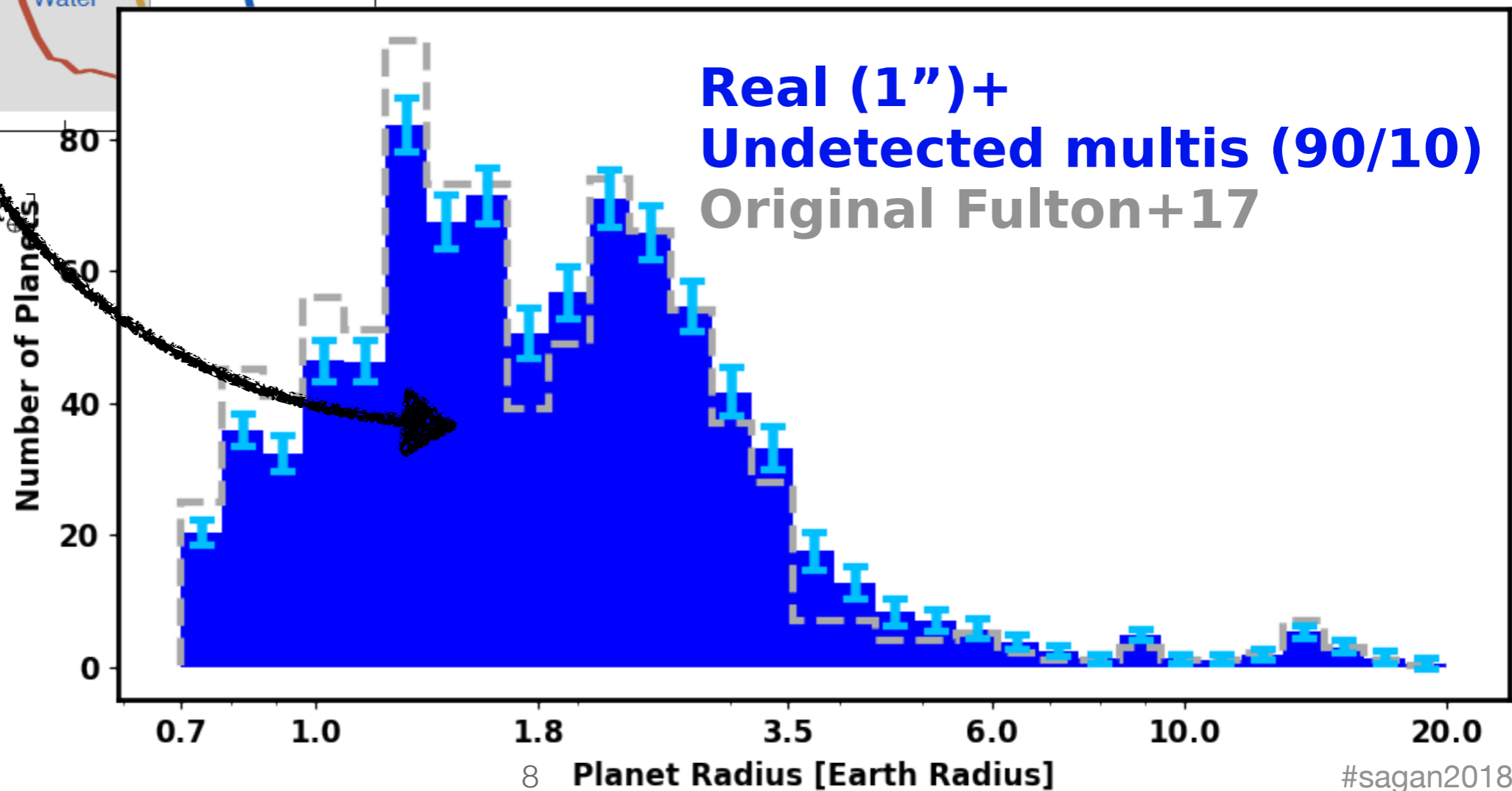


Hint of “smearing out” of radius distribution



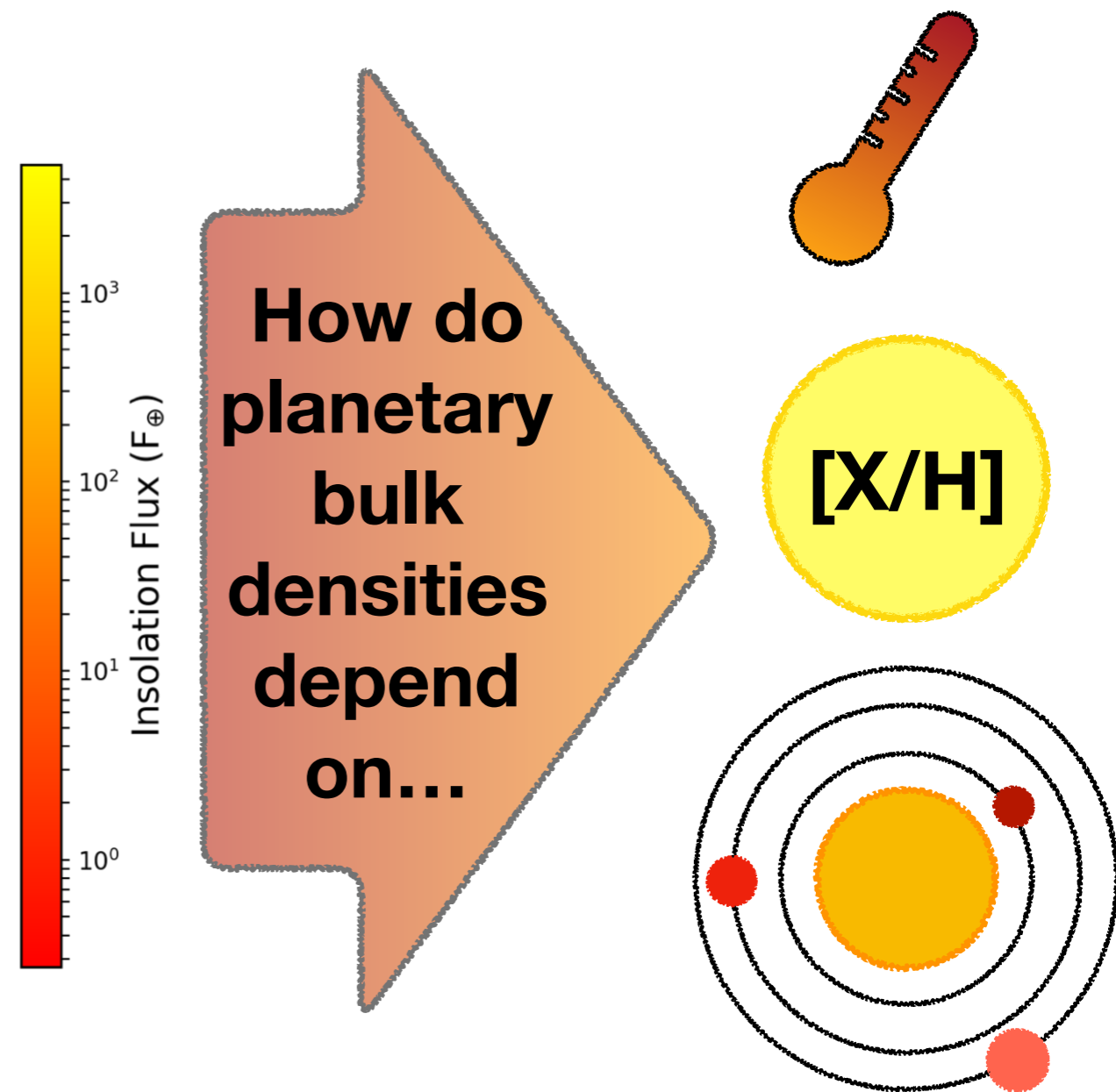
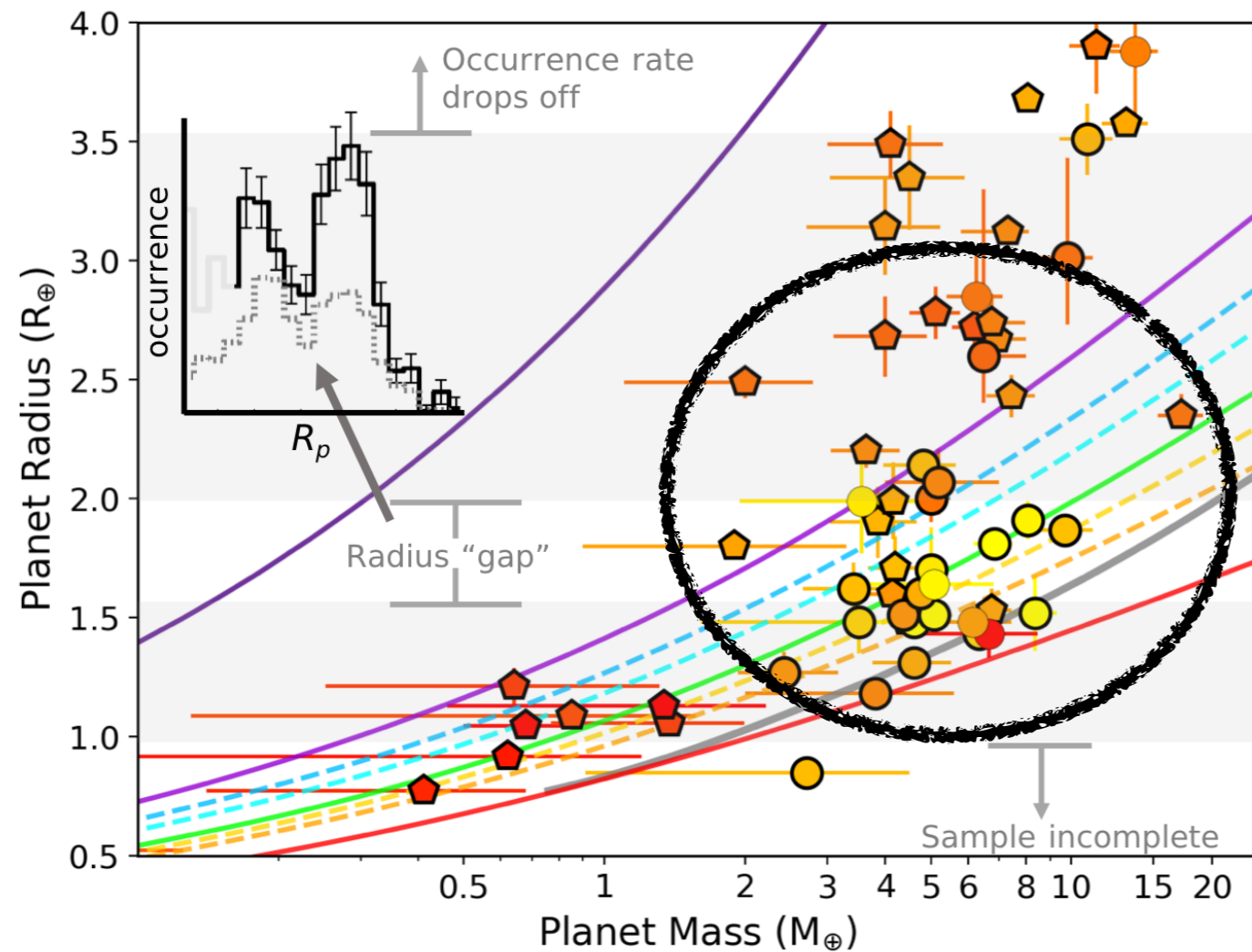
heterogeneity in core composition, and thus formation?

*Teske+18*





**Whether super-Earths and sub-Neptunes represent a continuous or distinct populations remains open. We want to further explore this problem with TESS planets.**



# Comprehensive Target Vetting



**Light Curves & Transit Candidates**  
**Reconnaissance Spectroscopy**  
**High-Resolution Imaging**  
**Photometric Monitoring**

# Comprehensive Target Vetting

## Robust Target Selection/Ranking



Per sector, before any new RV data are acquired

$$\text{merit} = \begin{cases} F_{\text{insol}}^{-1/3} \times T_{\text{exp}}^{-1} \times e^{-1.25(R_p - 1.8)^2} & \text{for } R_p < 3 R_{\oplus} \\ 0 & \text{otherwise} \end{cases}$$

# Comprehensive Target Vetting

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$t_{\text{exp}}$  needed to reach  $\sigma_{\text{rv}} = 2$  m/s  
(minimum  $t_{\text{exp}}$  10 min)

$K$  from Wolfgang+16

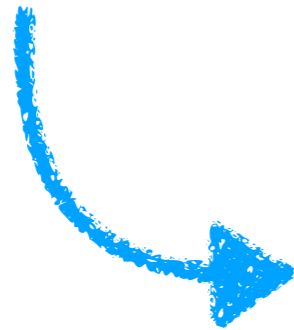
$\sqrt{N_{\text{obs}}} \cdot K / \sigma_{\text{rv}} \geq 6$   
(minimum  $N_{\text{obs}} = 20$ )

$N_{\text{obs}} \times t_{\text{exp}}$

# Comprehensive Target Vetting

## Robust Target Selection/Ranking

### RV Strategy Customized to Each Target



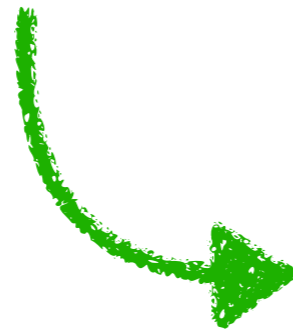
Consider planet orbital periods,  
stellar rotation period,  
stellar active region lifetime  
Total time x 3 for realistic requirement

**Comprehensive Target Vetting**

**Robust Target Selection/Ranking**

**RV Strategy Customized to Each Target**

**Publish Mass Constraints at end of Survey**



**Regardless of statistical significance**

**Avoid bias in mass-radius relation**

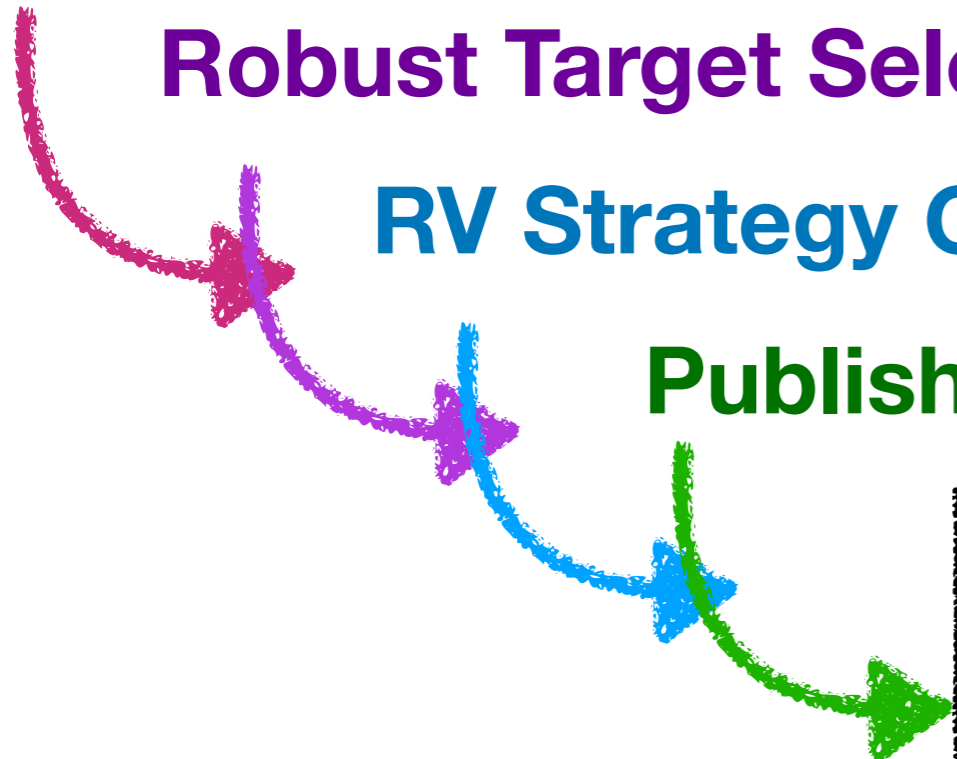
**Share plans in ExoFOP TESS**

# Comprehensive Target Vetting

## Robust Target Selection/Ranking

## RV Strategy Customized to Each Target

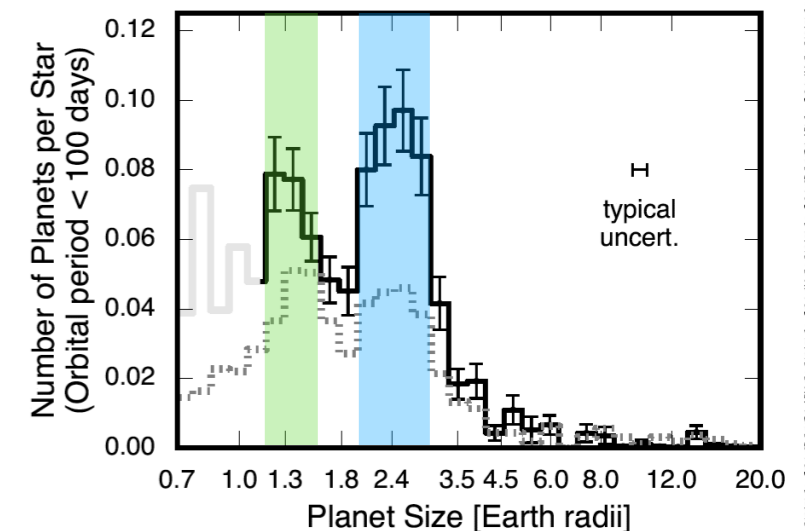
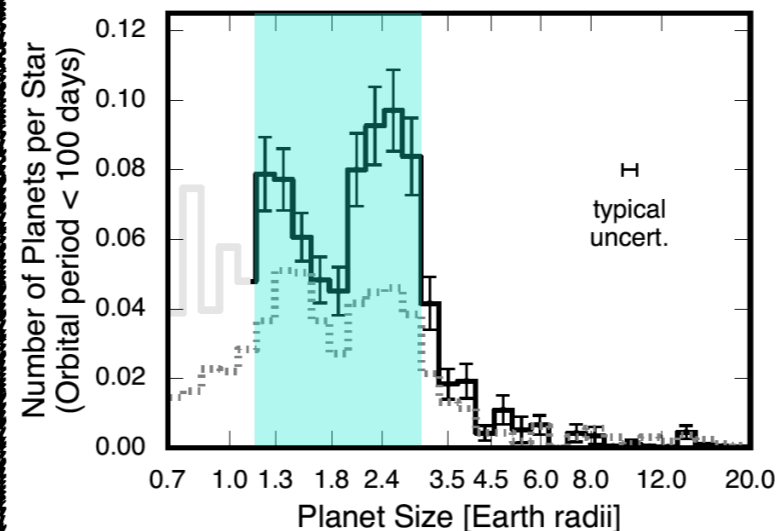
## Publish Mass Constraints at end of Survey



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# Comprehensive Target Vetting

Robust Target Selection/Ranking

RV Strategy Customized to Each Target

Publish Mass Constraints at end of Survey



**~30 new small, well-characterized planets**

**Updated M-R relation**

**Longer period planet constraints**

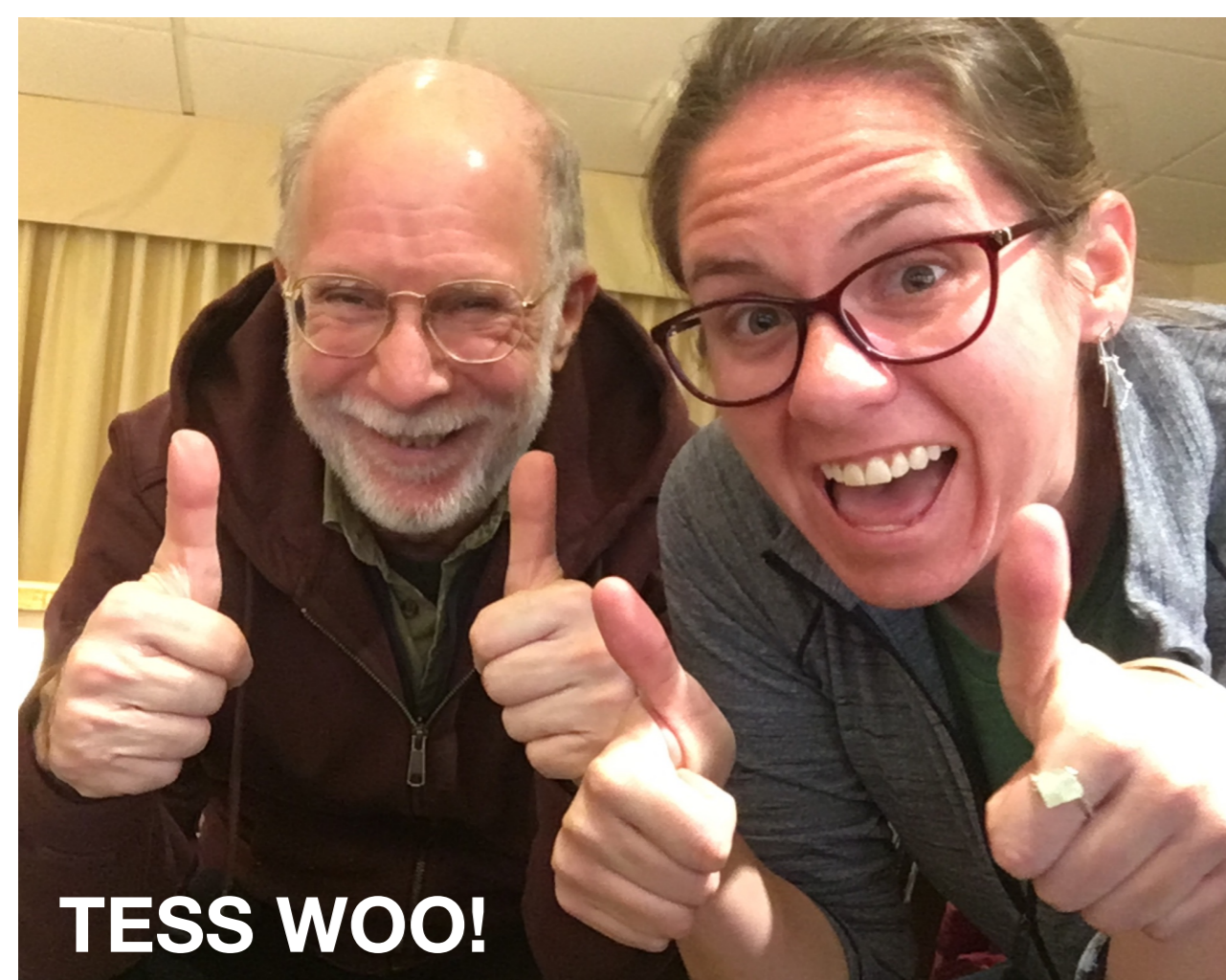
**RV obs for other groups to combine with additional data**

**Host star compositions**

**Stellar rotation periods**

**High-resolution images**





**TESS WOO!**

**First PFS-TESS observing run October 13-27**

**Sector 1 top-ranked/chosen targets were pi Men c & TOI 134 (GJ4332)**

**Papers in prep!**

