Testing the photoevaporation model with TESS multis

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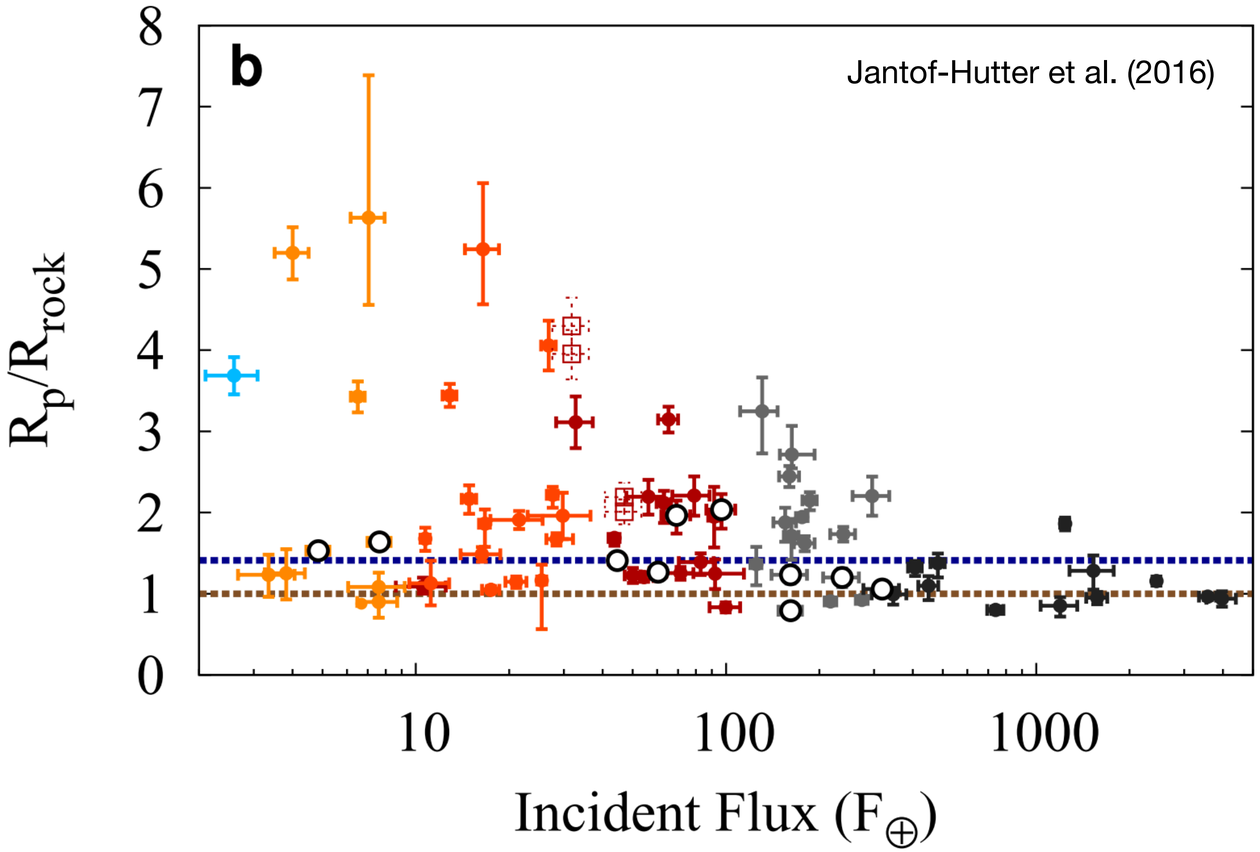
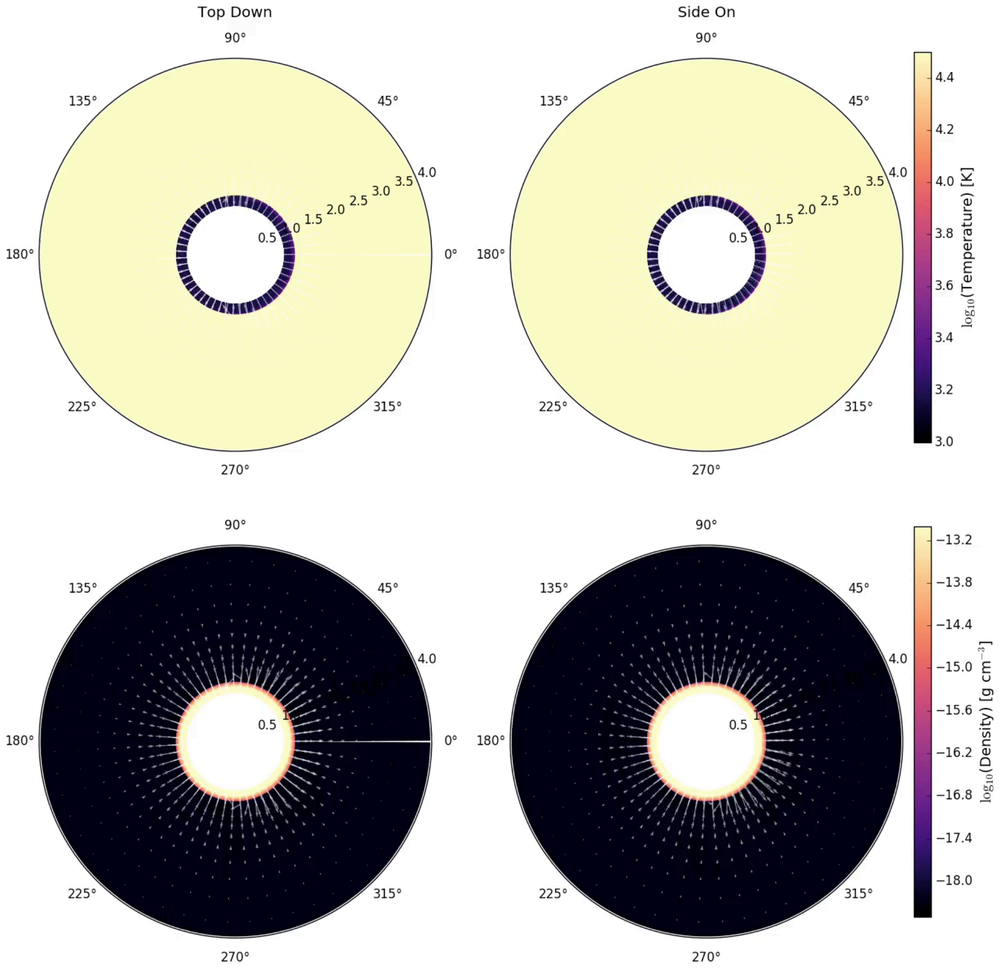
THE ROYAL SOCIETY

The photoevaporation model - motivation

Observations



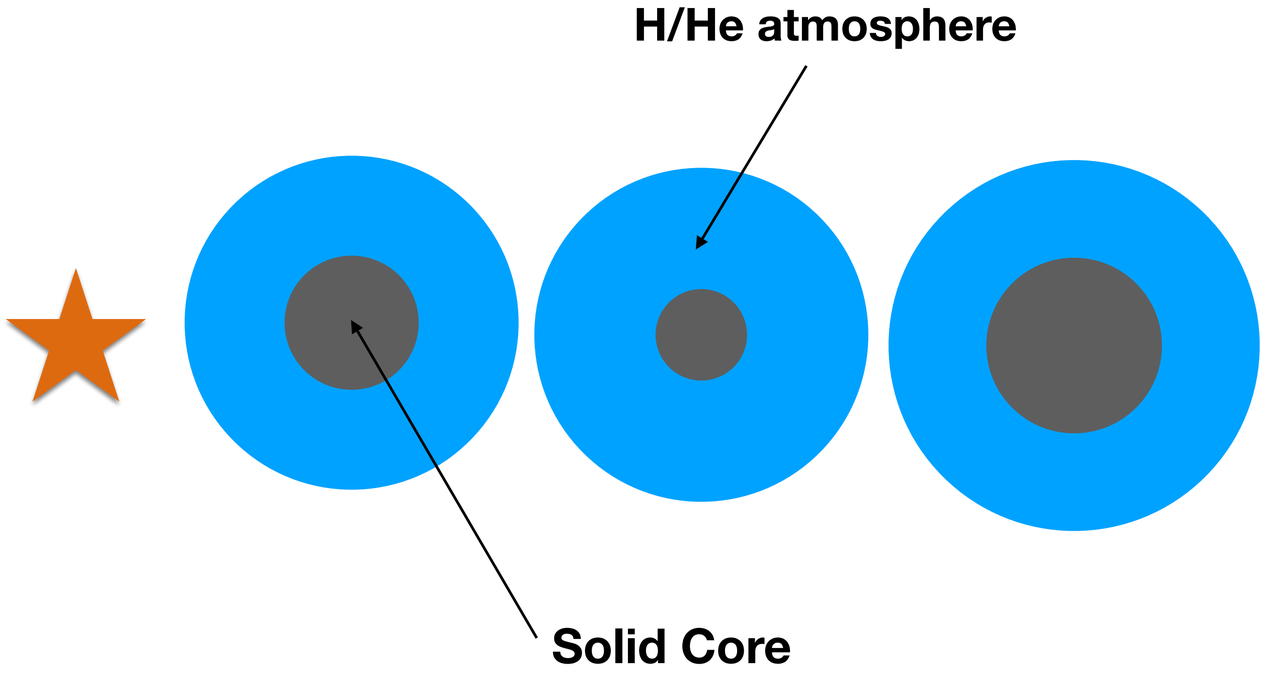
Simulations



Owen et al. (in prep)

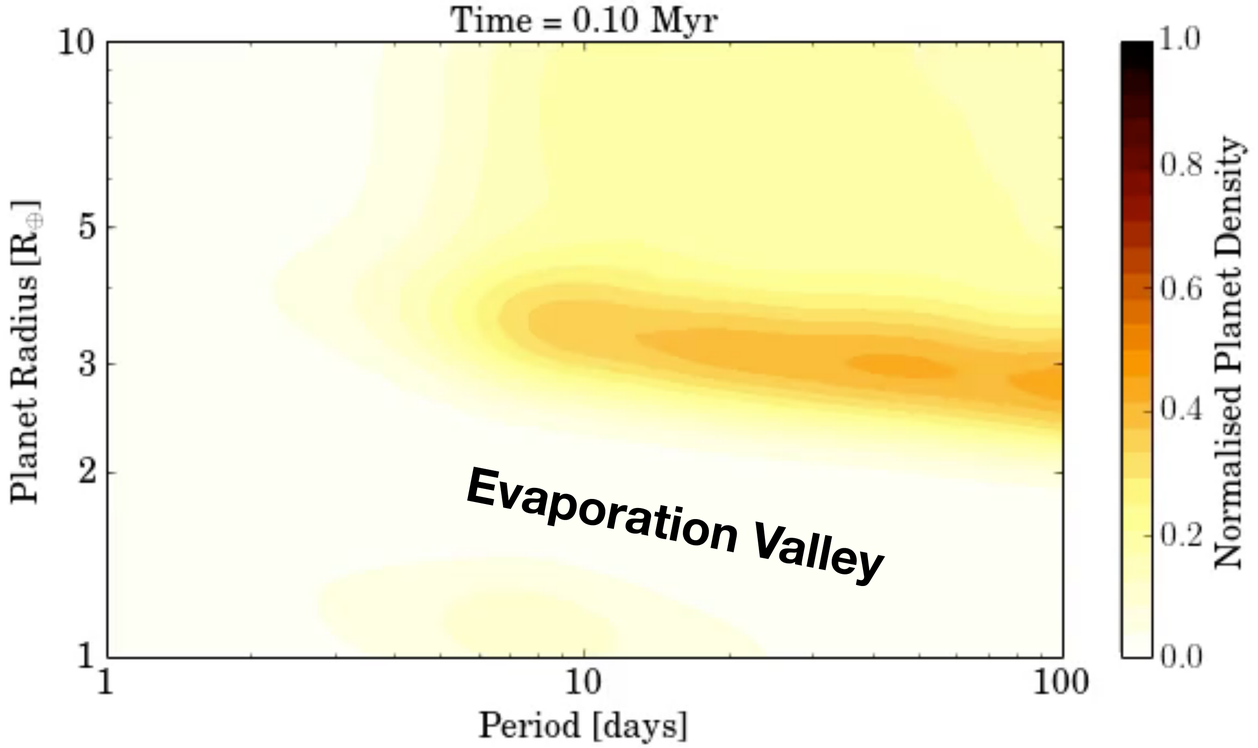
Photoevaporation driven evolution

“Planets with ~1% H/He atmospheres”



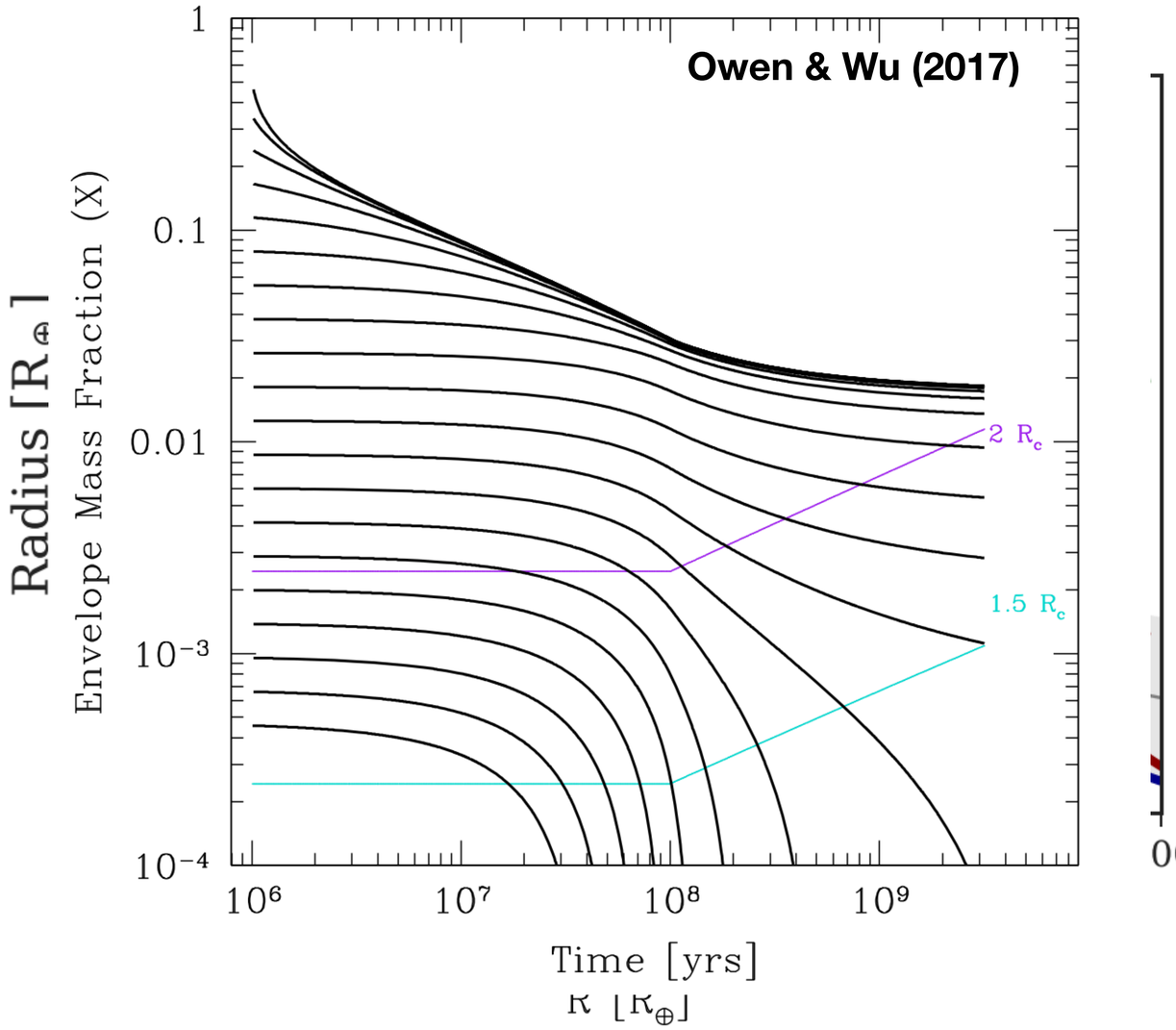
“Stripped Cores”

Owen & Wu (2013, 2017)

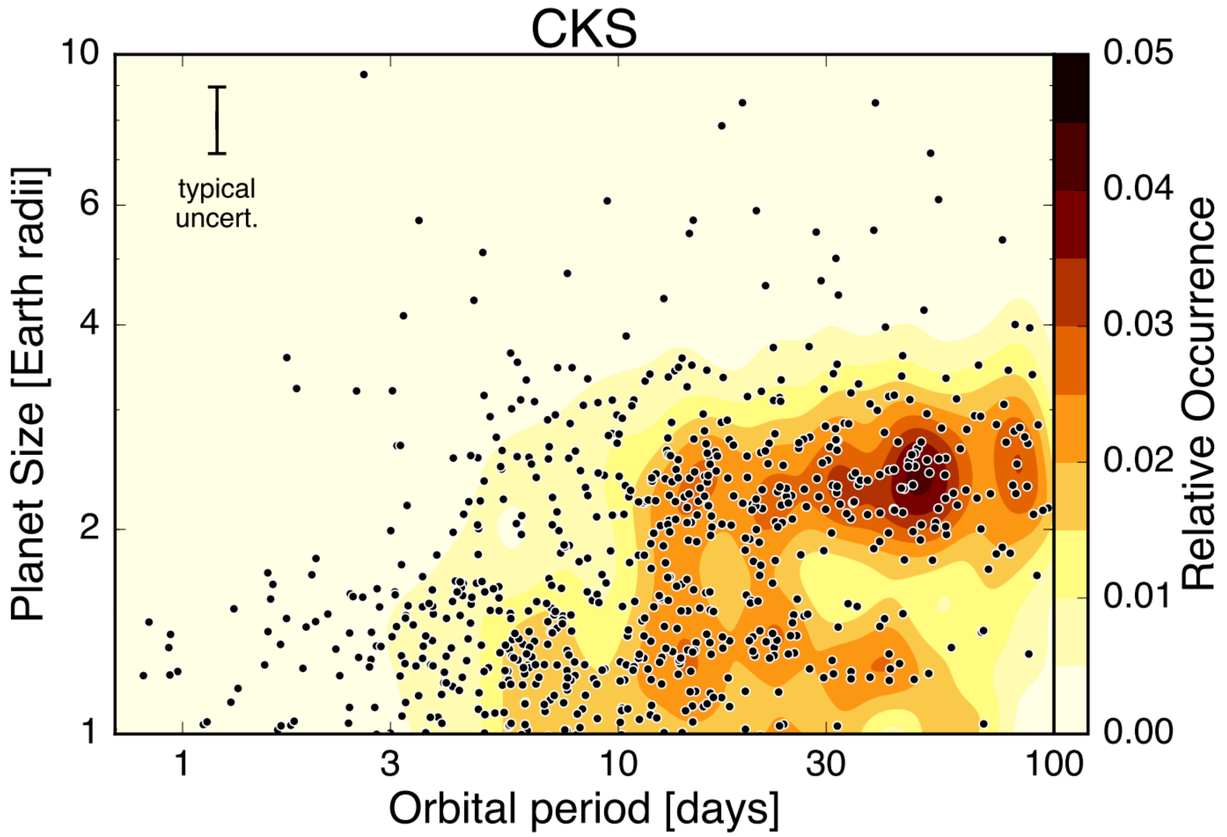


Inferences if you believe photoevaporation!

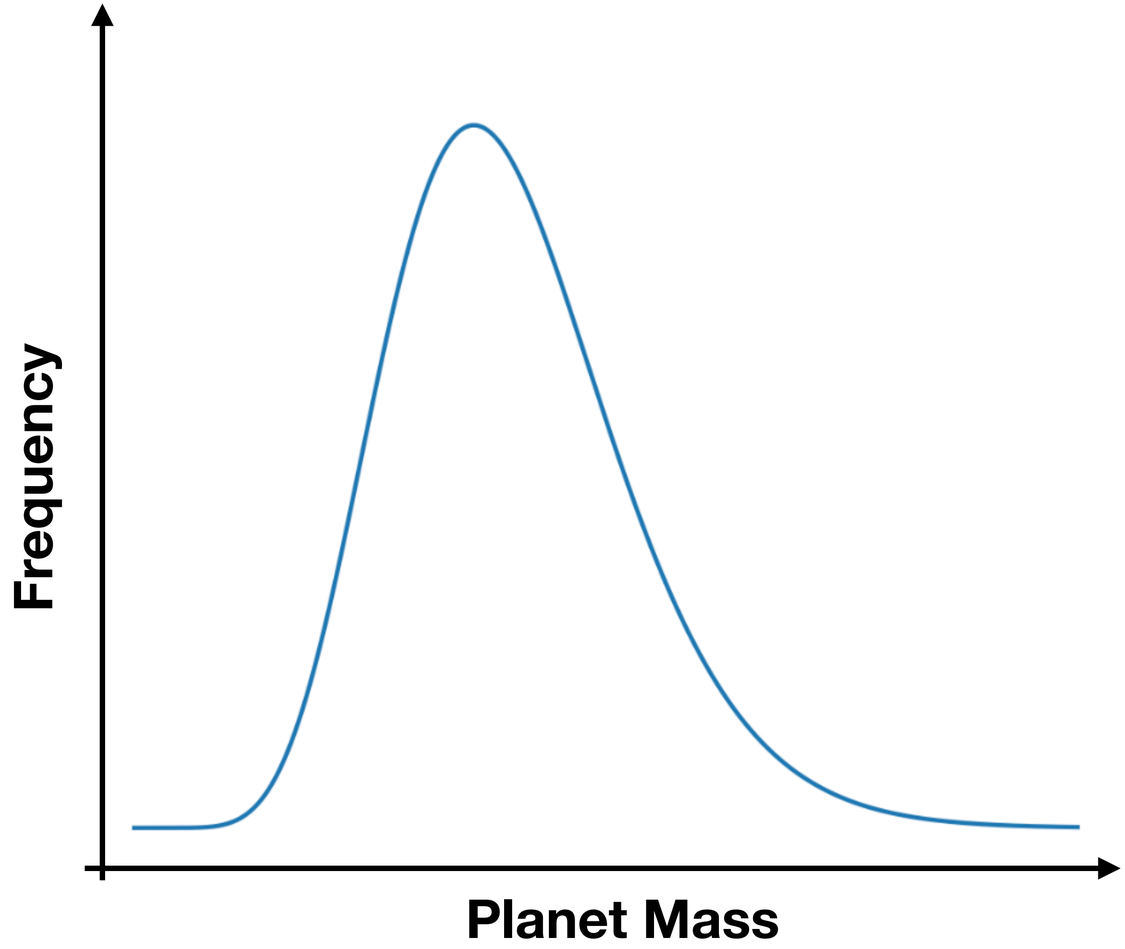
1. Core composition is uniform.
2. The Core composition is “Earth-like”.
3. Planets have been on their observed orbits for most of their lives.
4. Planets formed before gas disc dispersal and acquire > 1% by mass atmospheres.



Without planet masses, photoevaporation is an unconstrained problem



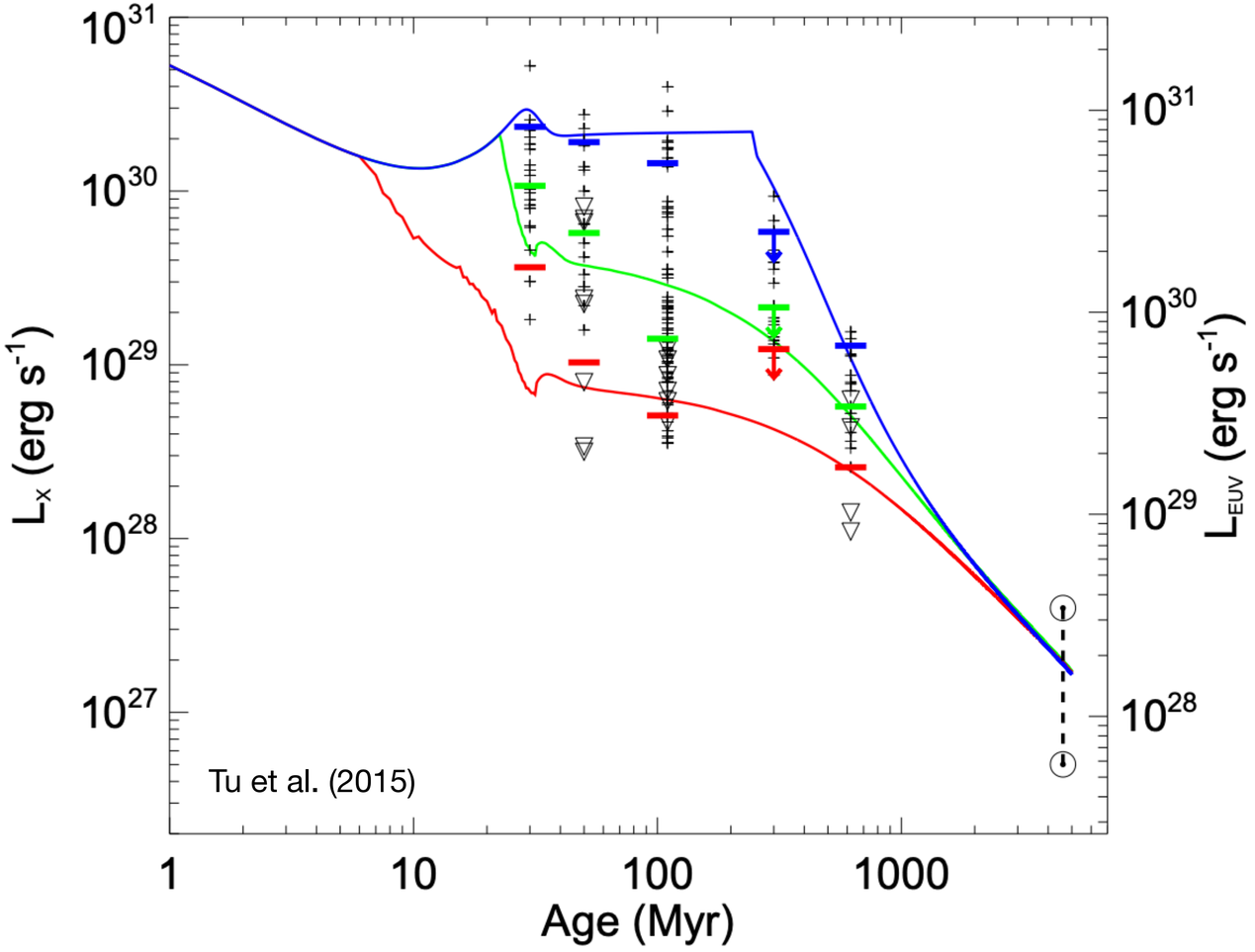
Fulton et al. (2017)

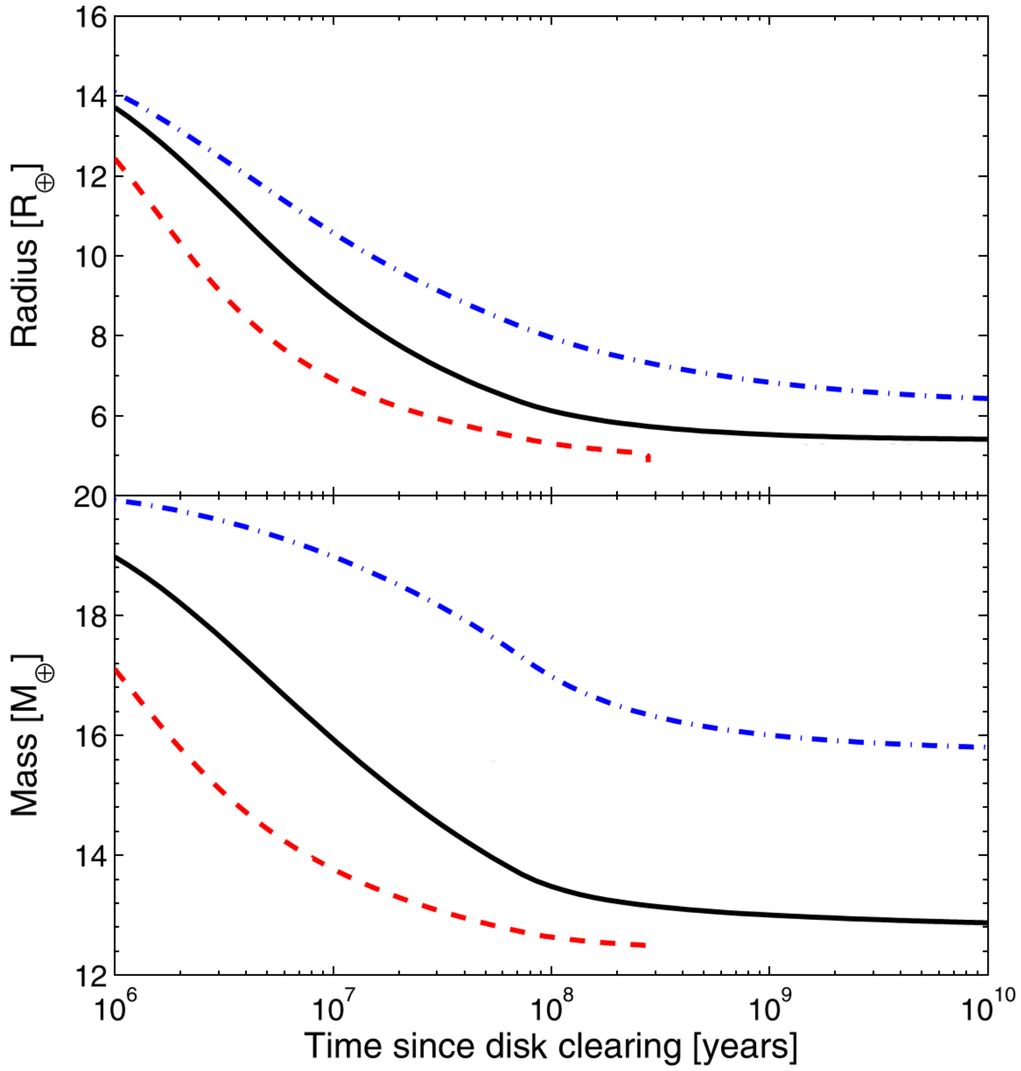


How to test photoevaporation - measure masses!

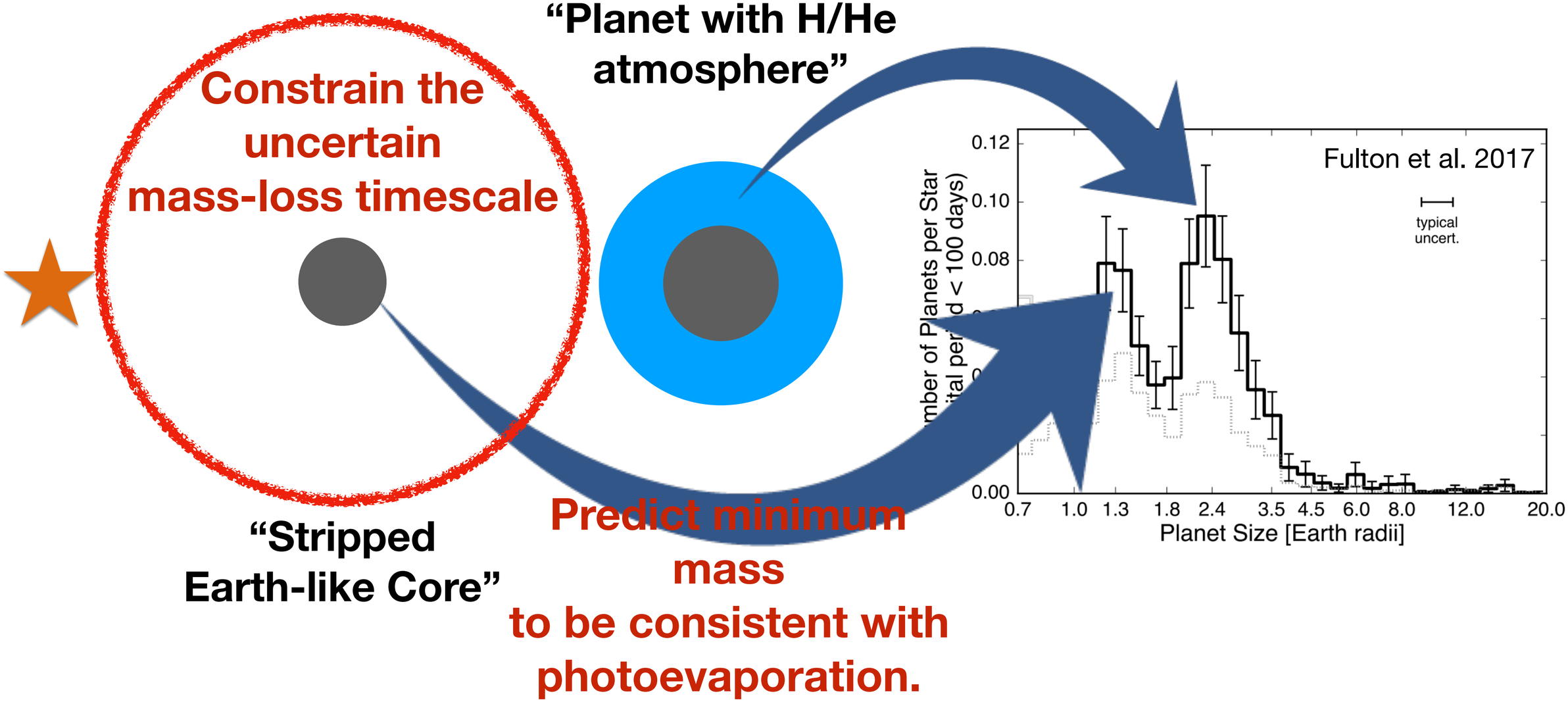
… but there’s a problem!

The problem - the mass-loss timescale is uncertain!





The solution - multis - “straddlers”



The way it works…

2.5 days

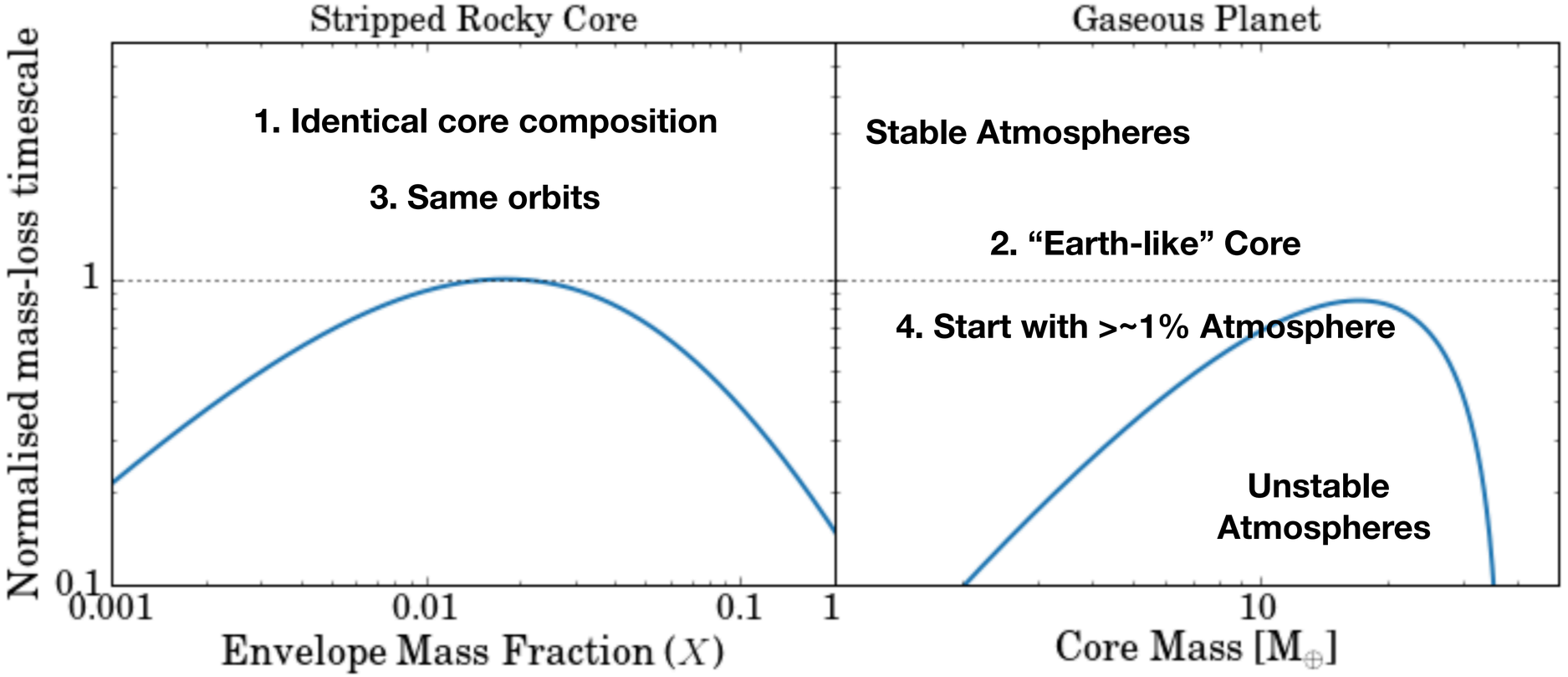
4 days

1.5 Rearth

5 days

2.5 Rearth

8 days



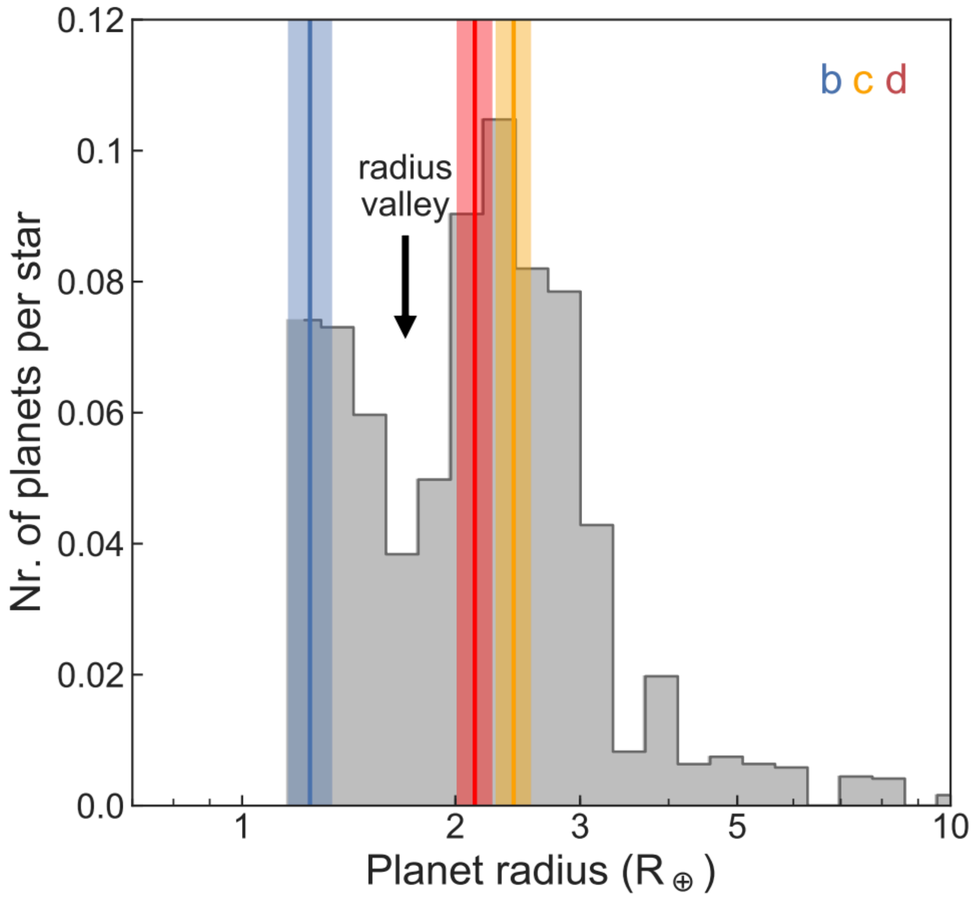
Why TESS? - we need masses

- Kepler has several hundred planets in multi-planet systems that are suitable for this method.
- Only 25 systems have any mass constraints. 24 systems are consistent.
- **Kepler-100 maybe inconsistent.**

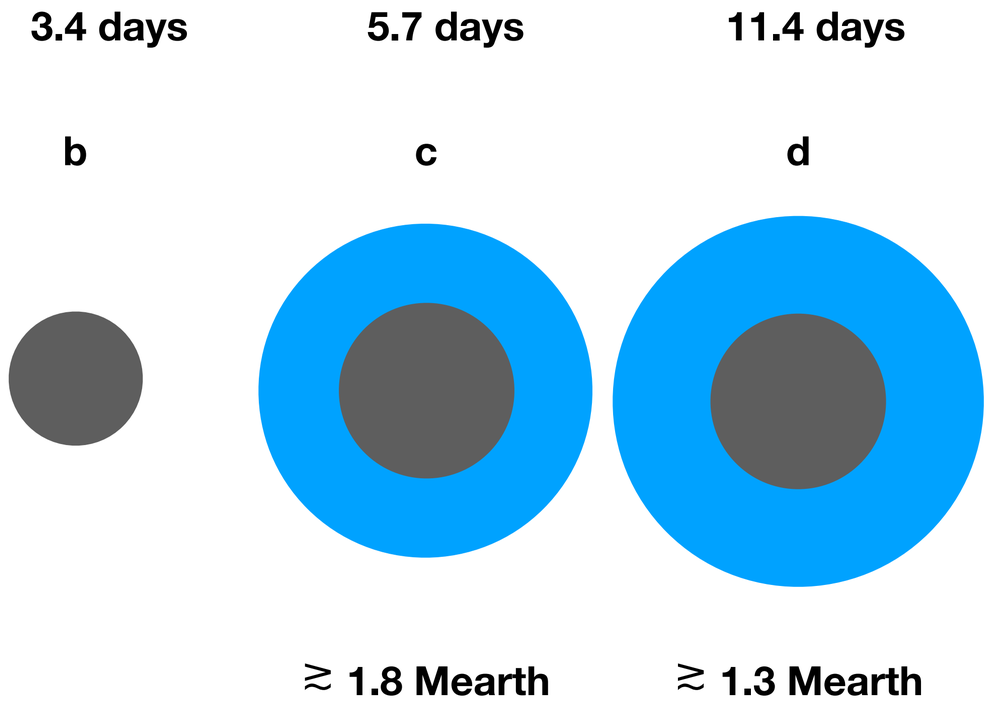
Beatriz Campos Estrada

Applying for PhD places this fall.

TESS Example - TOI 270



Günther et al. (2019)



≳ 1.8 Mearth

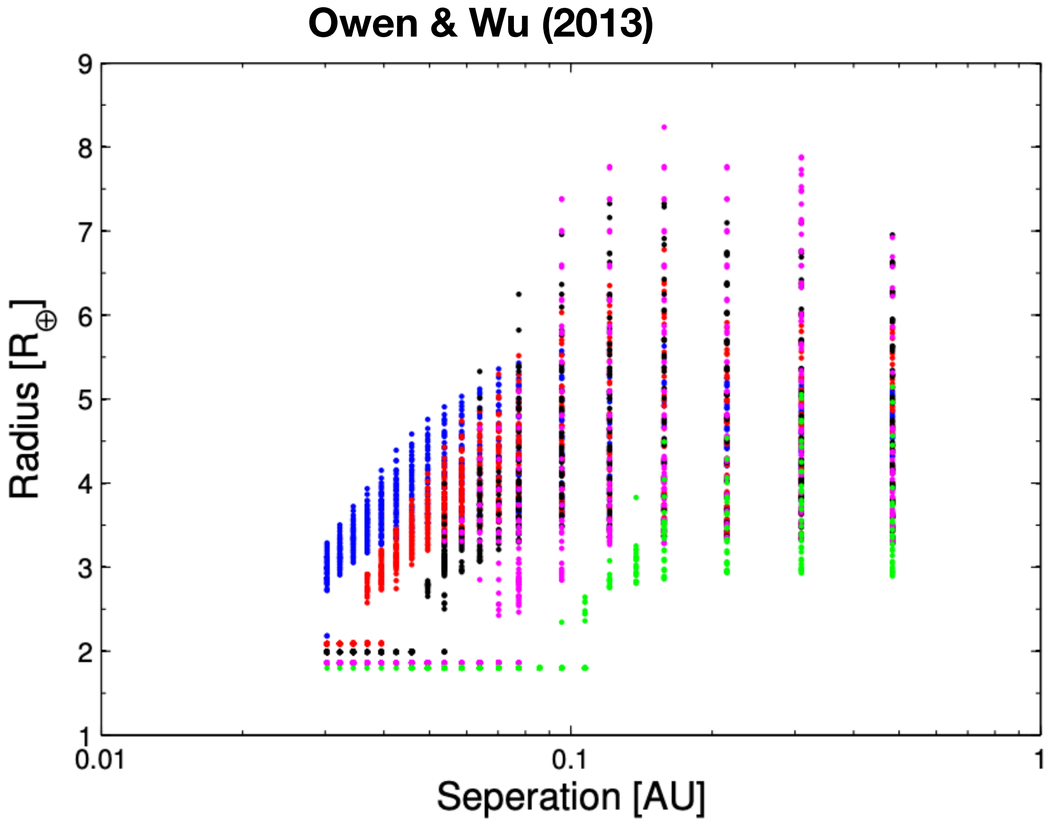
≳ 1.3 Mearth

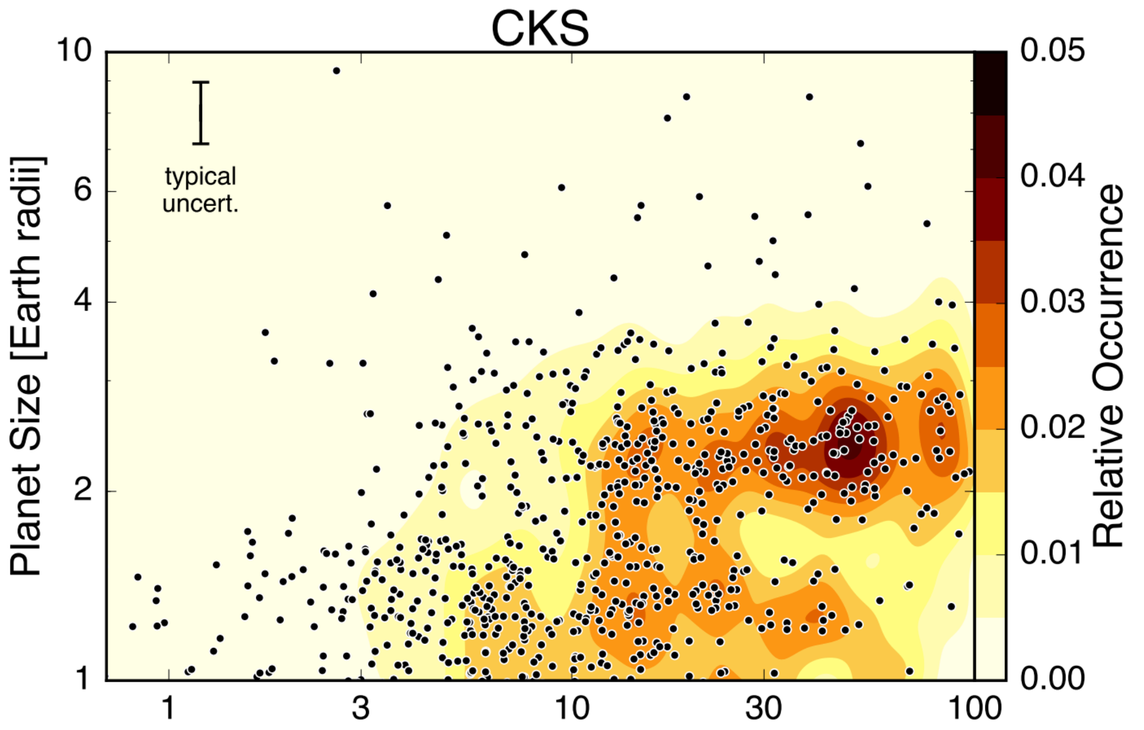
Do it yourself:

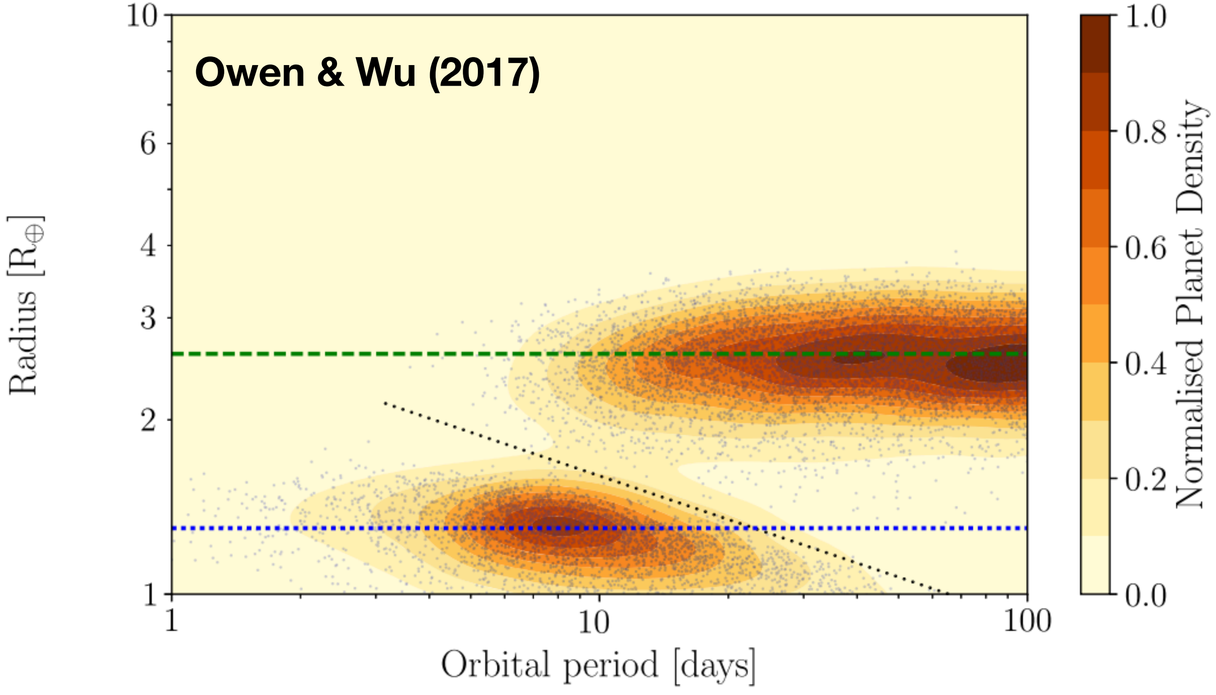
https://github.com/jo276/EvapMass

Summary

- **Multi-planet straddlers** are best systems for testing the photoevaporation model.
- Models can predict the minimum masses of “gaseous” planets to be consistent with photoevaporation.
- **Even upper-limits are constraining.**
- Maybe **prioritise multi-planet straddler** systems for follow-up masses.


Owen & Wu (2013)
Radius [R⊕]
Seperation [AU]
0.01
0.1
1
1
2
3
4
5
6
7
8
9


CKS
typical
uncert.
Planet Size [Earth radii]
Relative Occurrence
1
2
4
6
10
1
3
10
30
100
0.00
0.01
0.02
0.03
0.04
0.05


Owen & Wu (2017)
Radius [R⊕]
Orbital period [days]
Normalised Planet Density
1
2
3
4
6
10
1
10
100
0.0
0.2
0.4
0.6
0.8
1.0