A Stellar Age Dependence of the Planet Radius Gap

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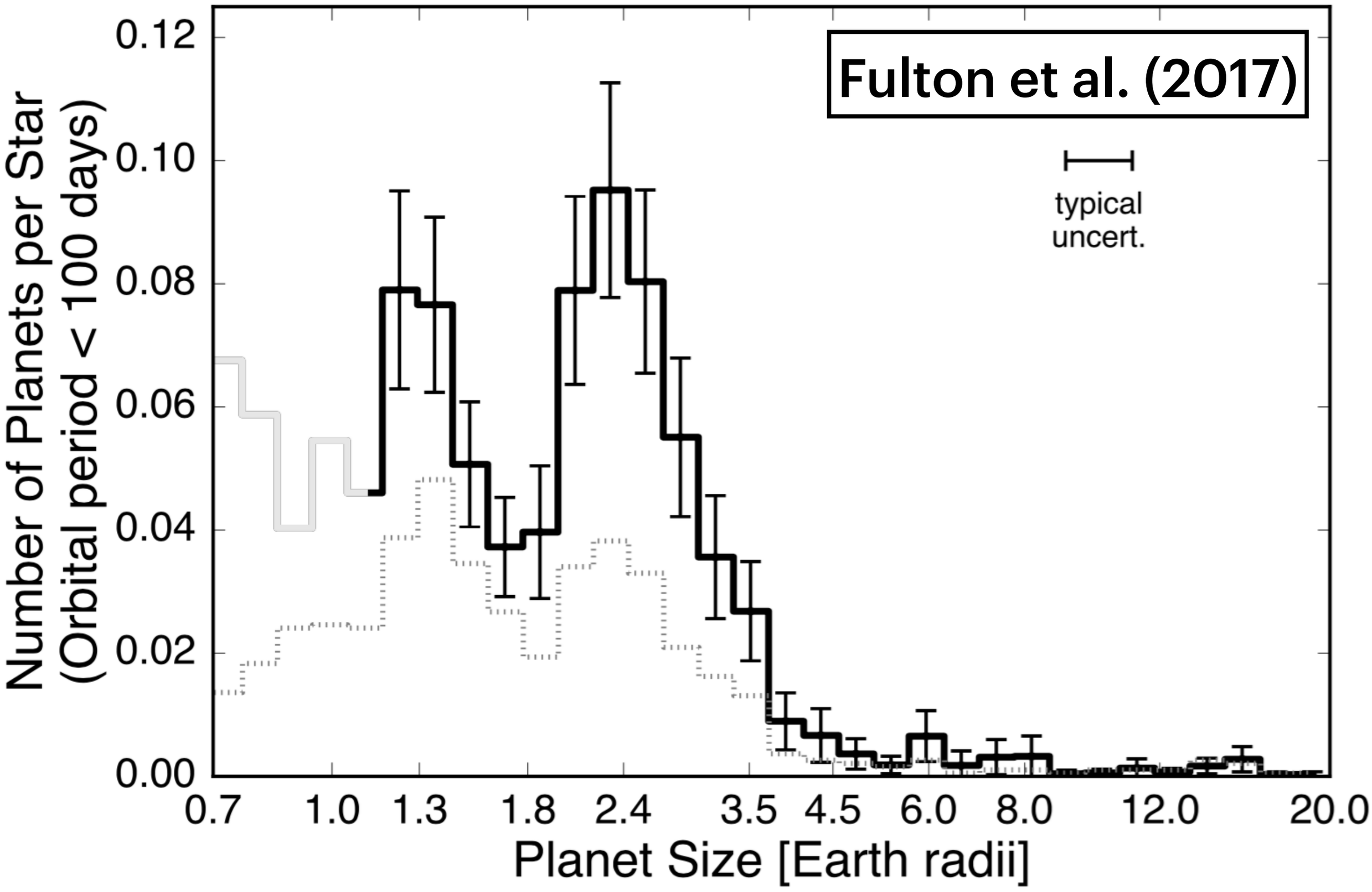
The Planet Radius Gap



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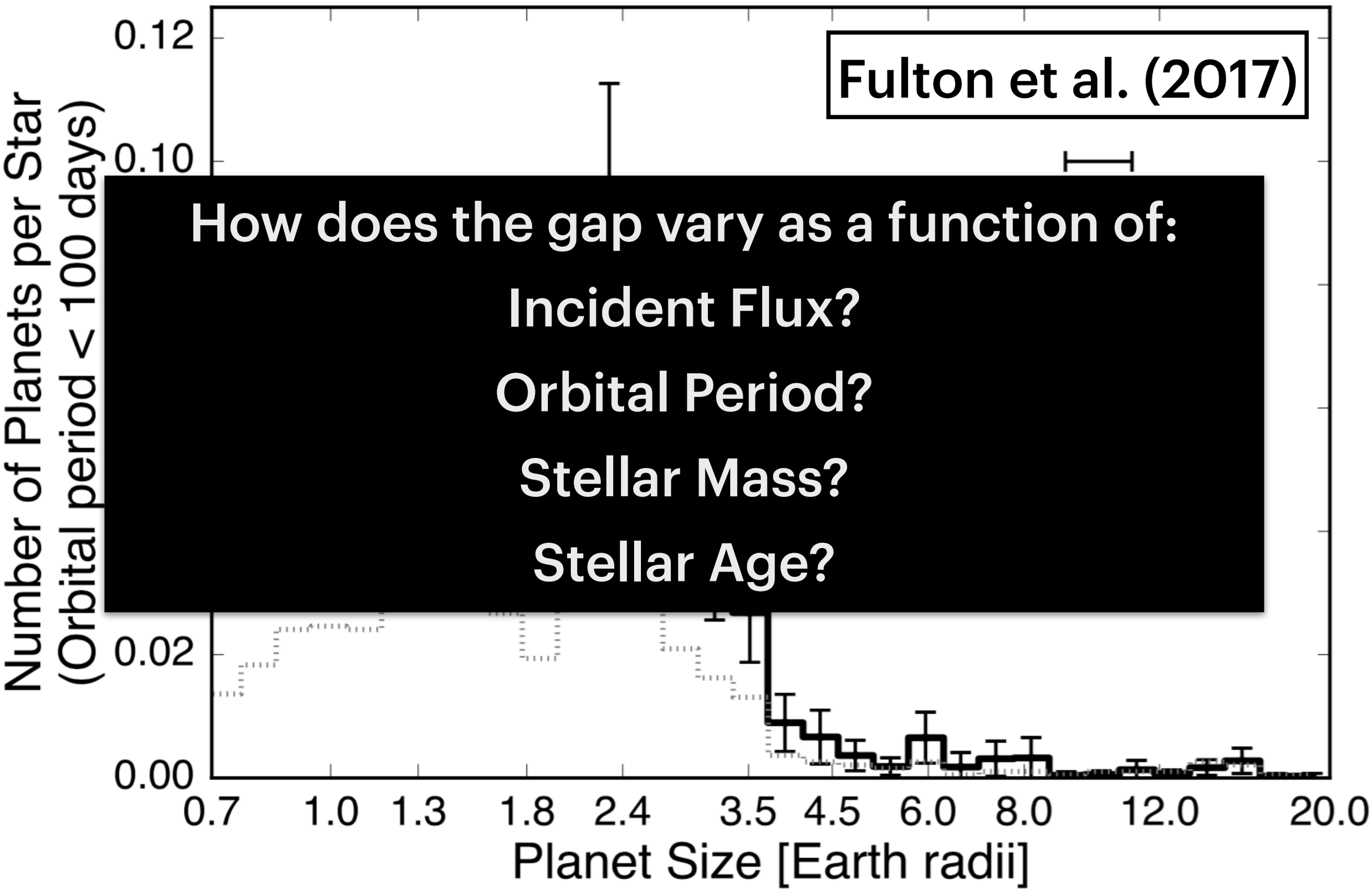

Two Competing Theories:

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1. Photoevaporation

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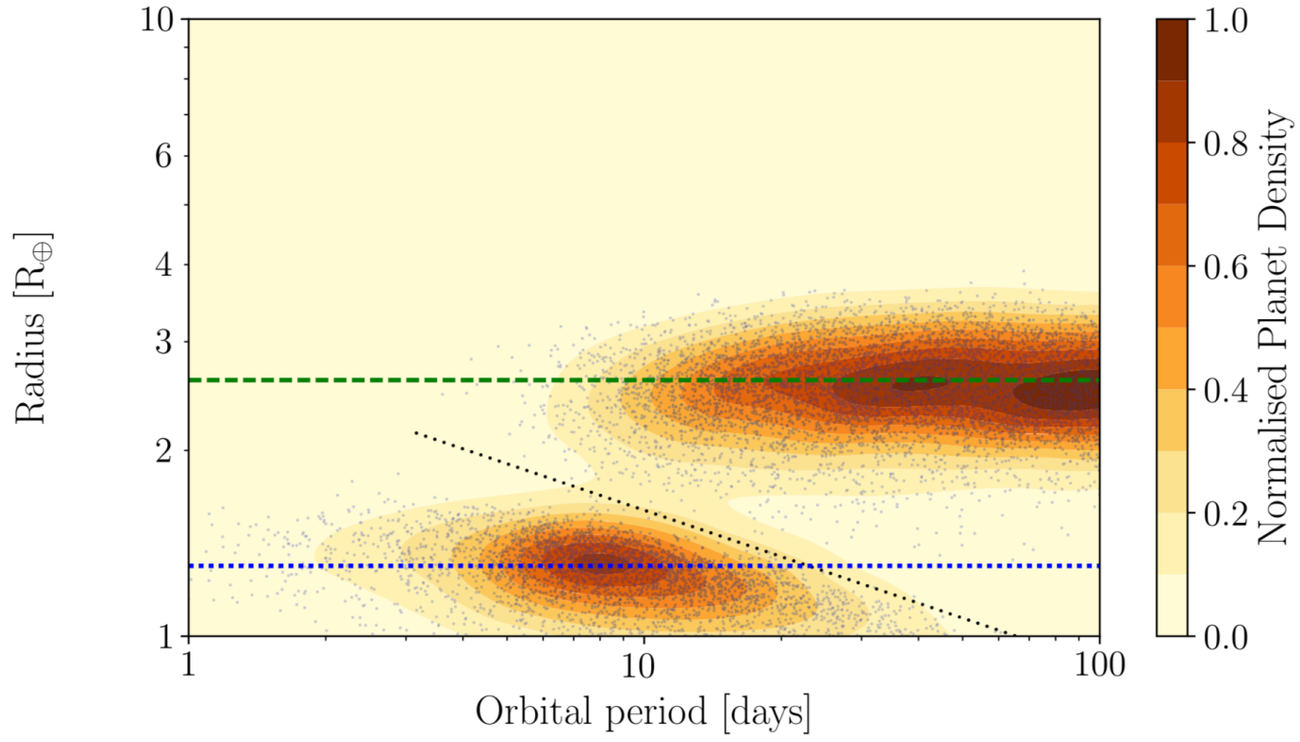
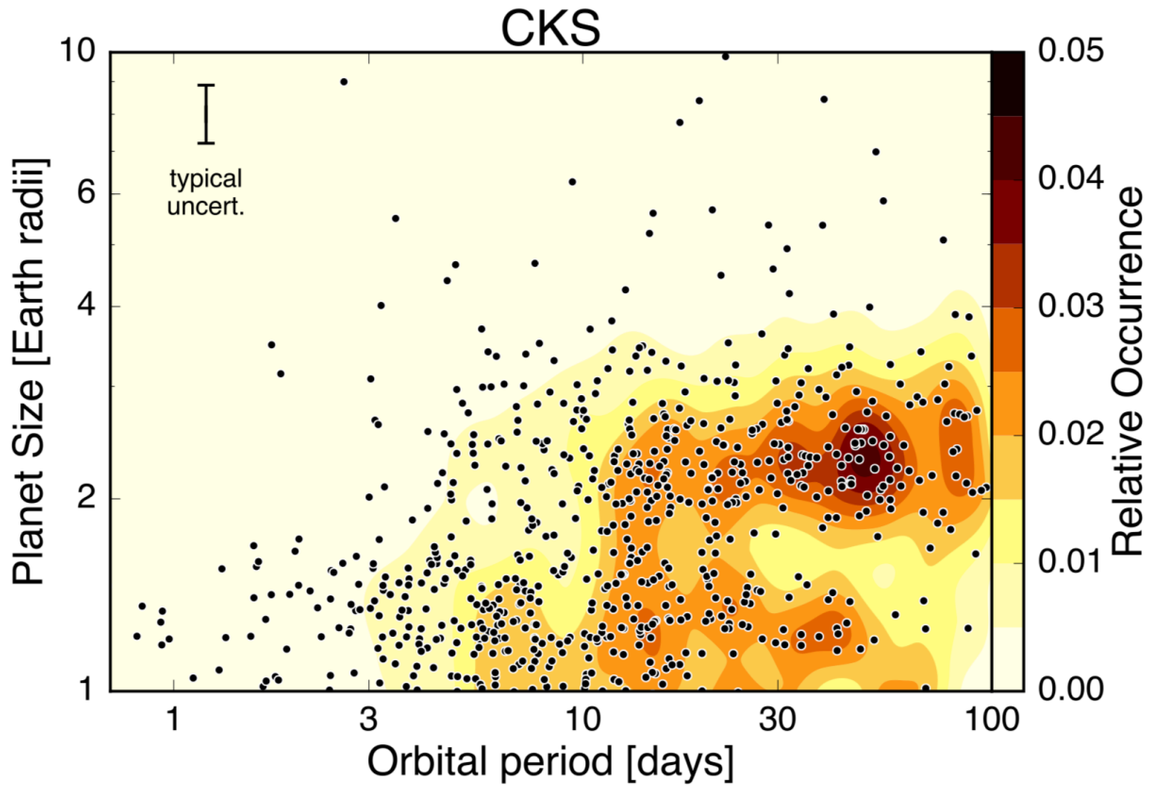
2. Core-powered mass-loss

1. Photoevaporation

Models



Observations

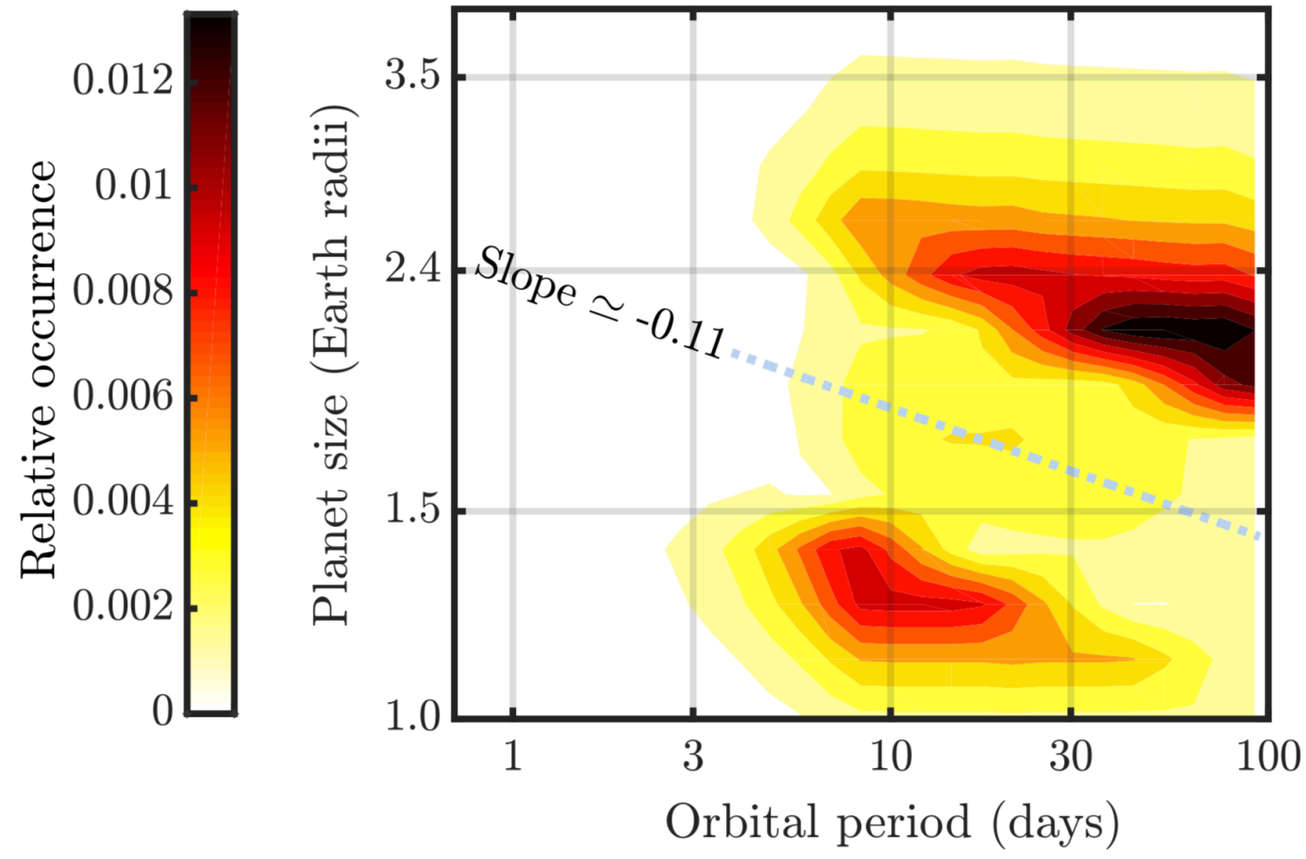


Owen & Wu (2017)

Fulton et al. (2017)

2. Core-powered mass-loss

Models



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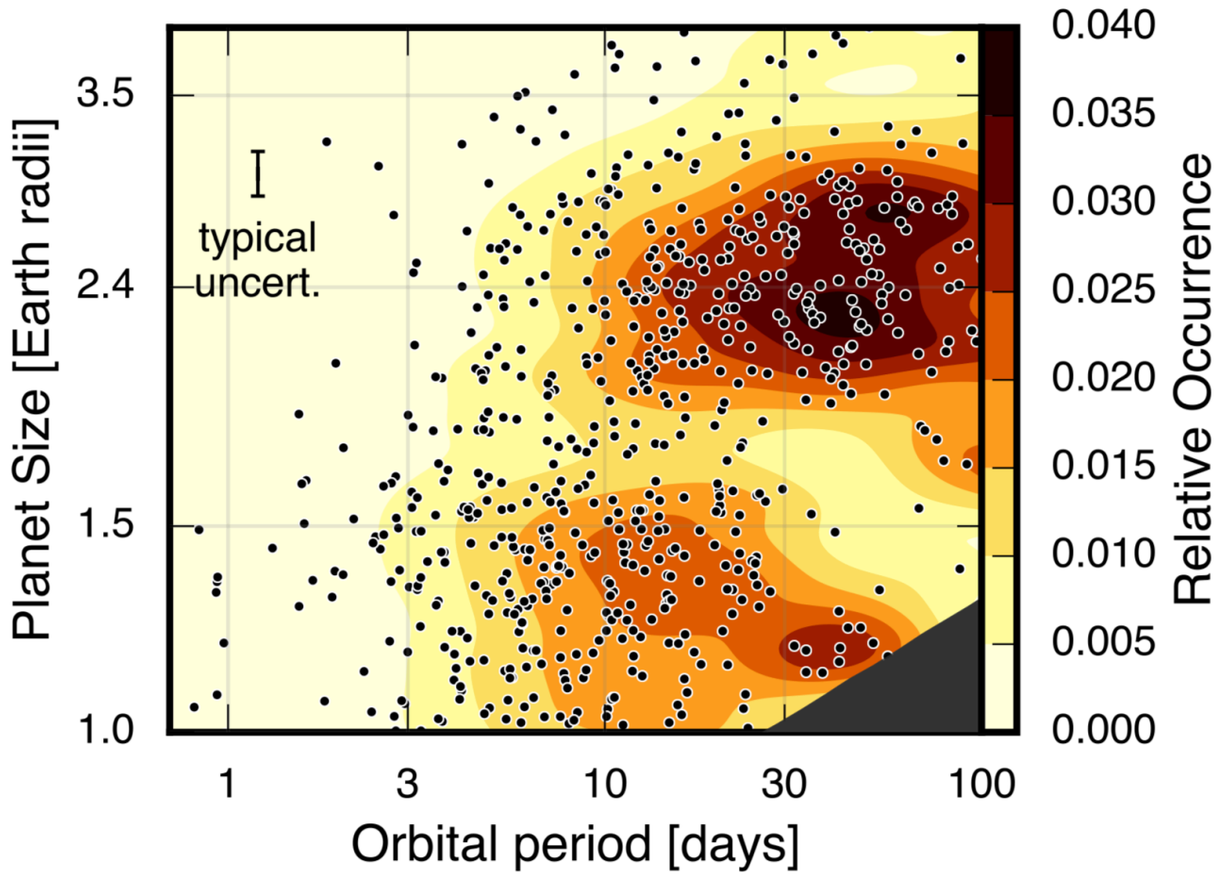
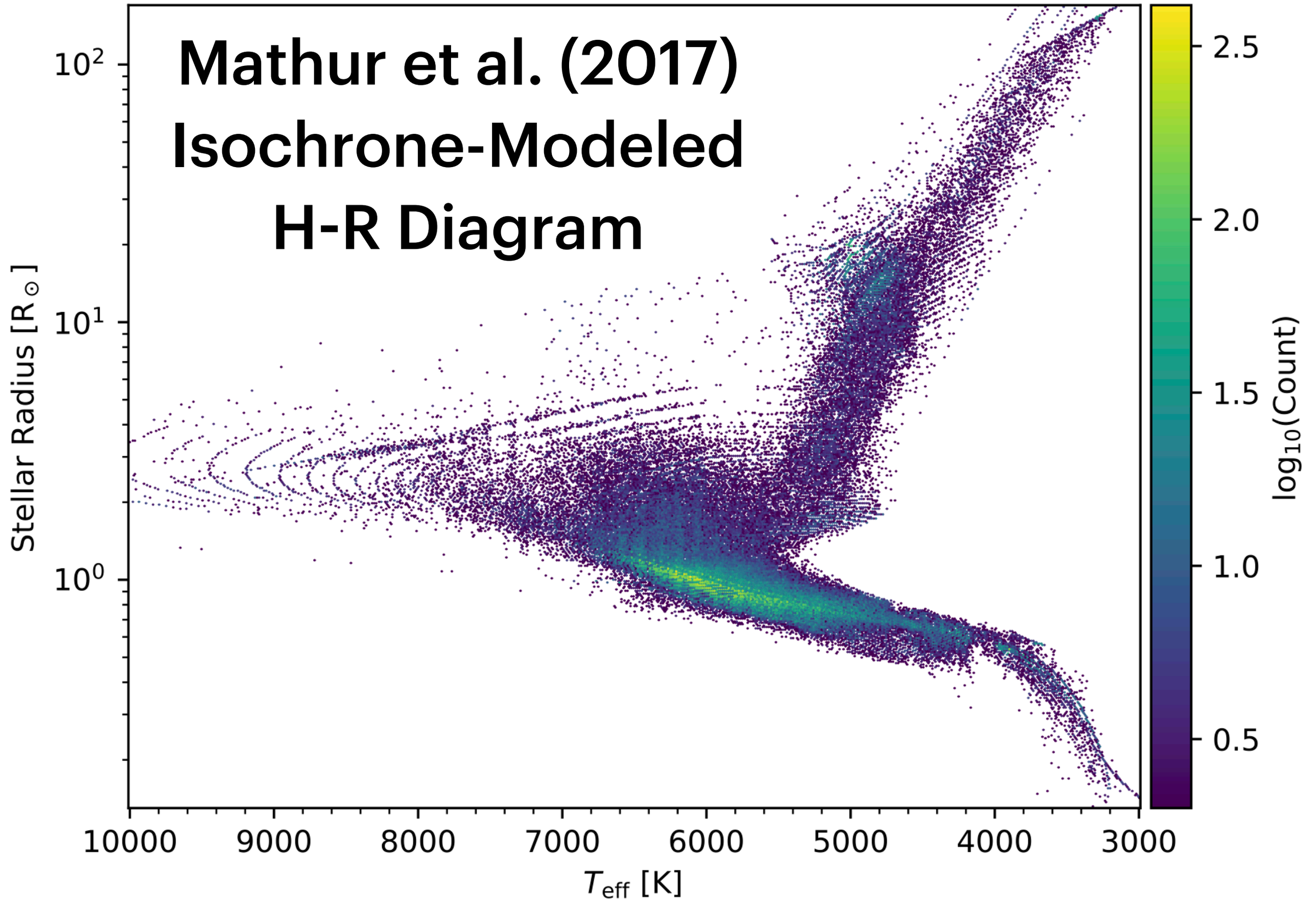


Gupta & Schlichting (2019)

Fulton & Petigura (2018)

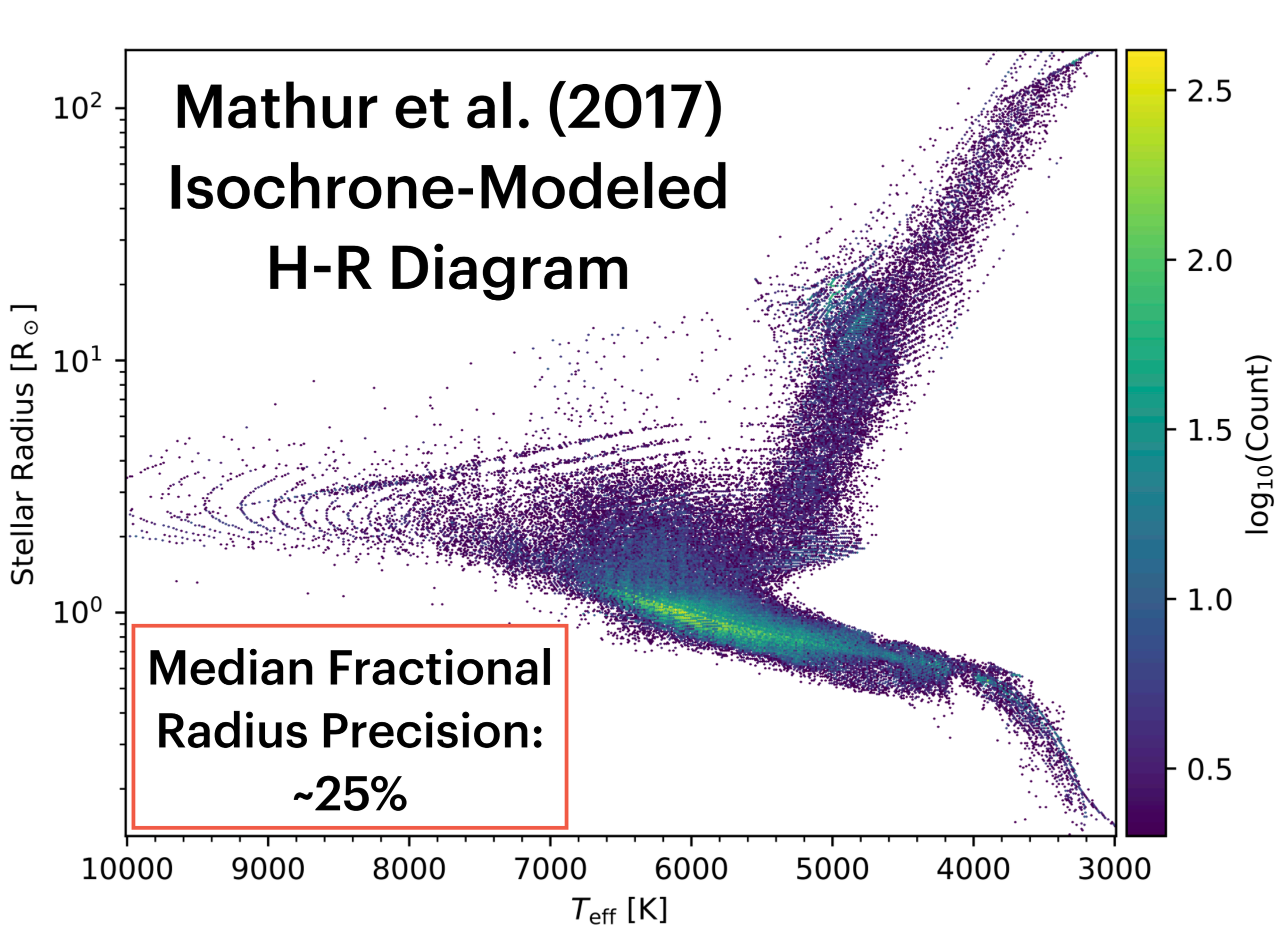
How do we differentiate between the two theories if both describe the observations well so far?

Mathur et al. (2017) Isochrone-Modeled H-R Diagram



Mathur et al. (2017) Isochrone-Modeled H-R Diagram

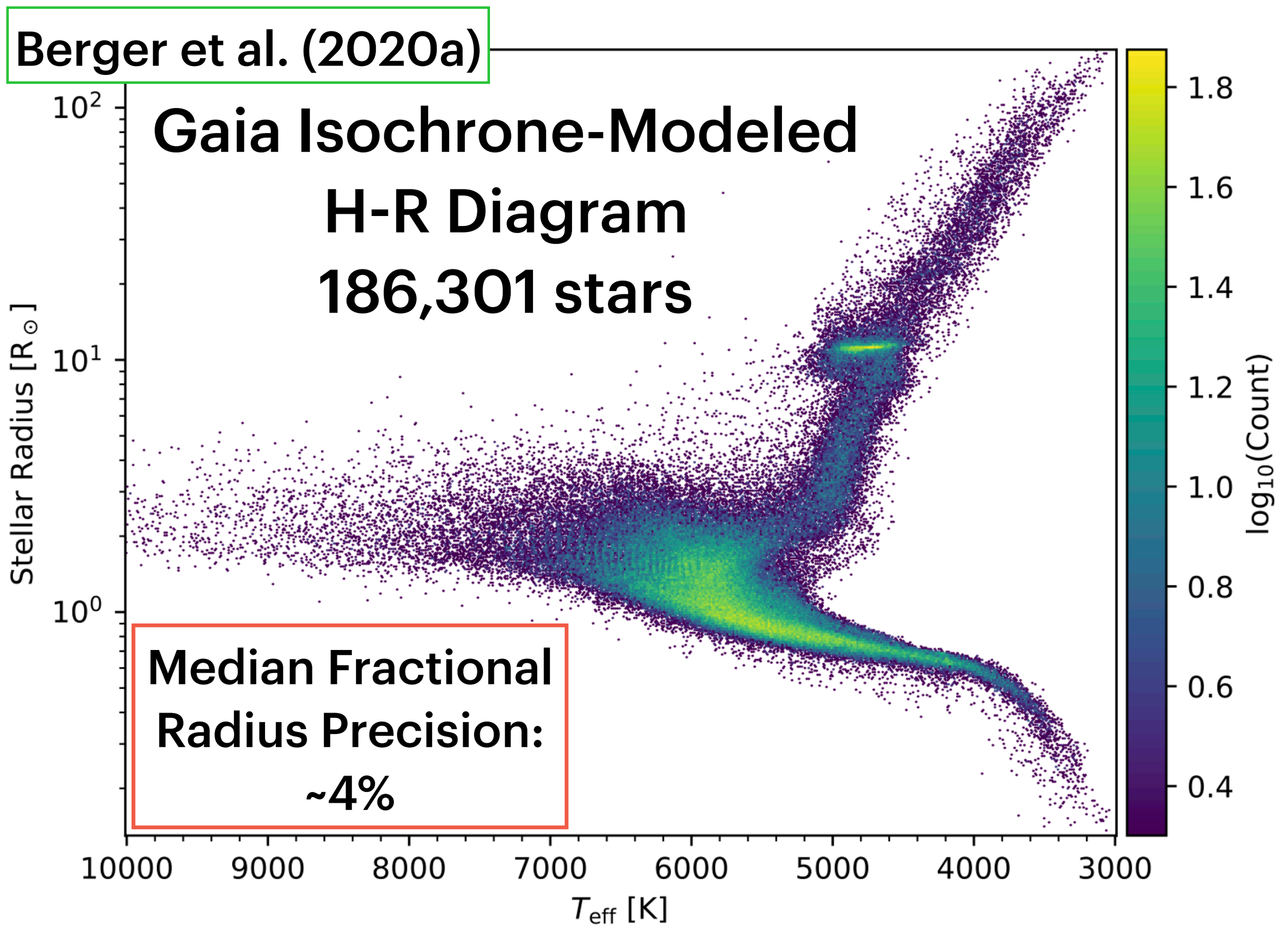
Median Fractional Radius Precision: ~25%



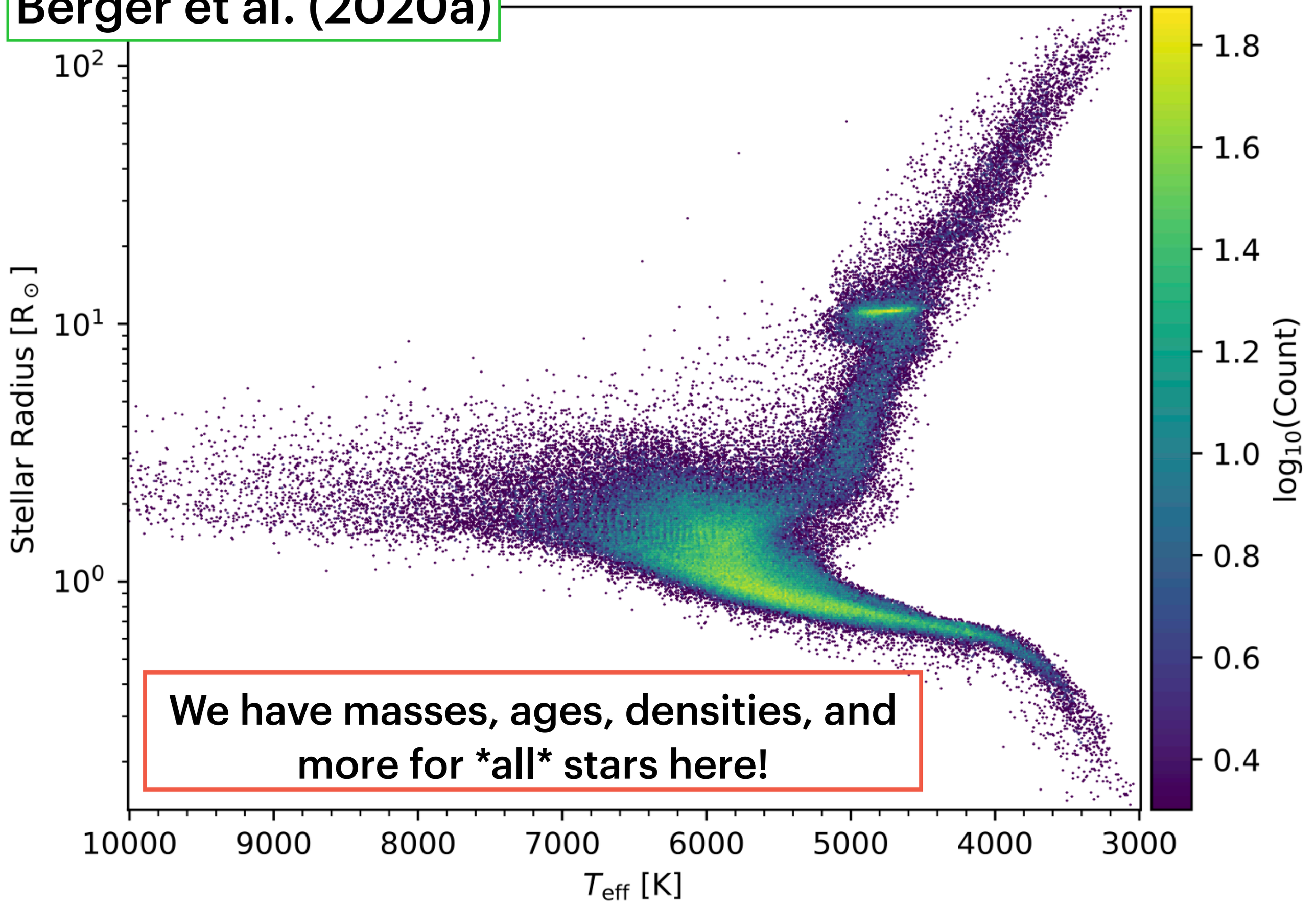
Berger et al. (2020a)

Gaia Isochrone-Modeled H-R Diagram 186,301 stars

Median Fractional Radius Precision: ~4%

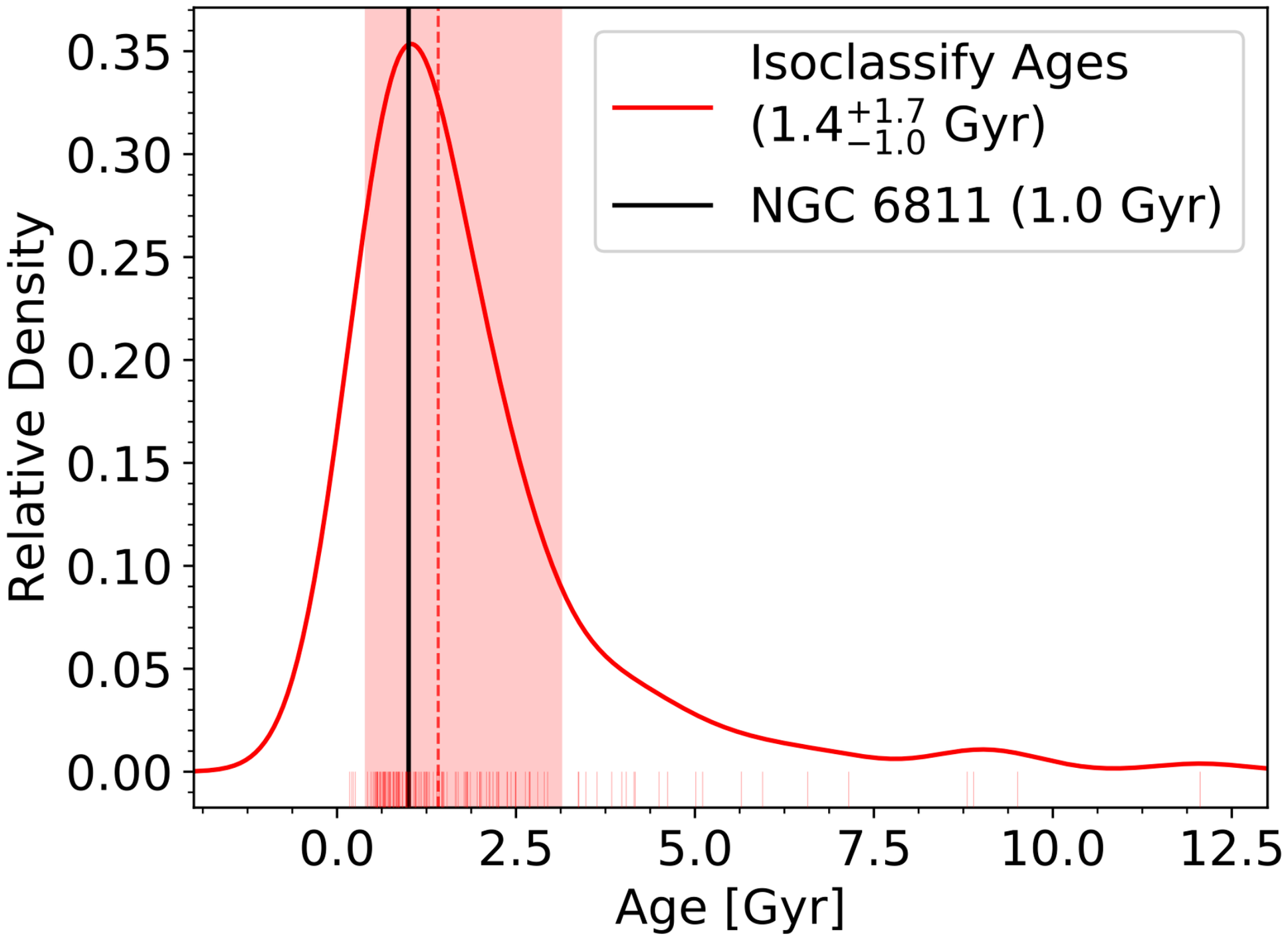


Berger et al. (2020a)



We have masses, ages, densities, and more for *all* stars here!

Age Validation: Clusters



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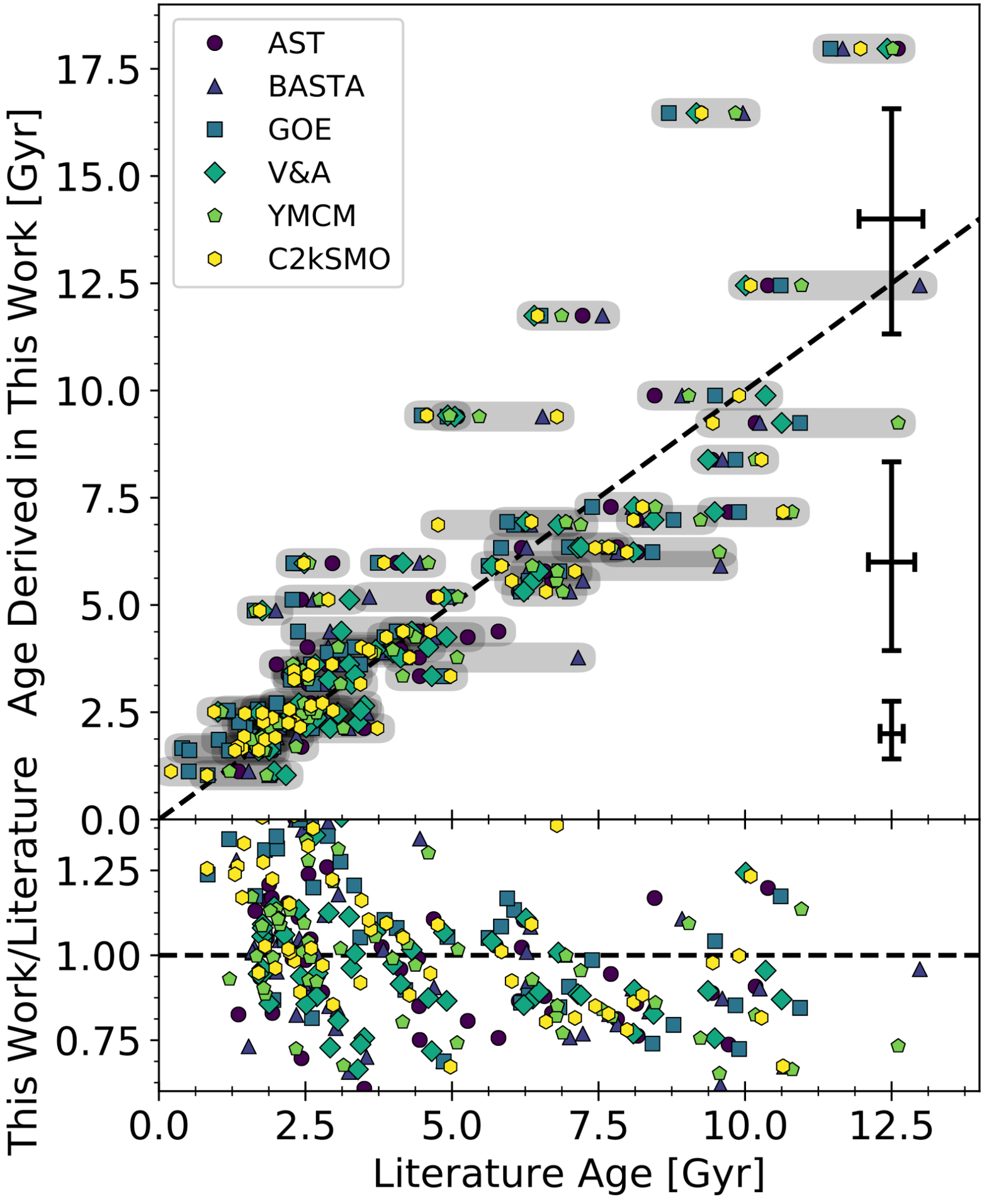
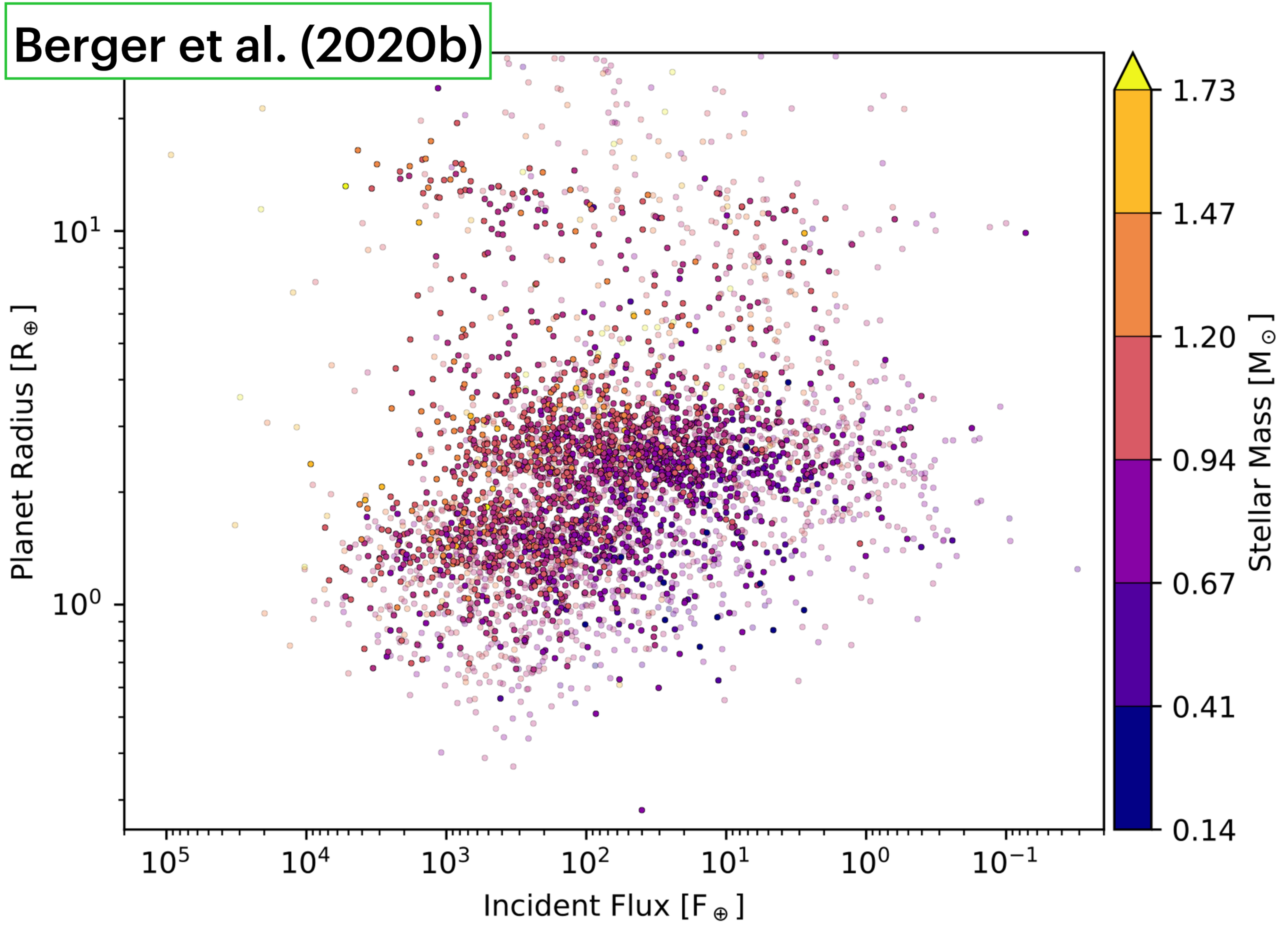


Age Validation: Astero-seismology

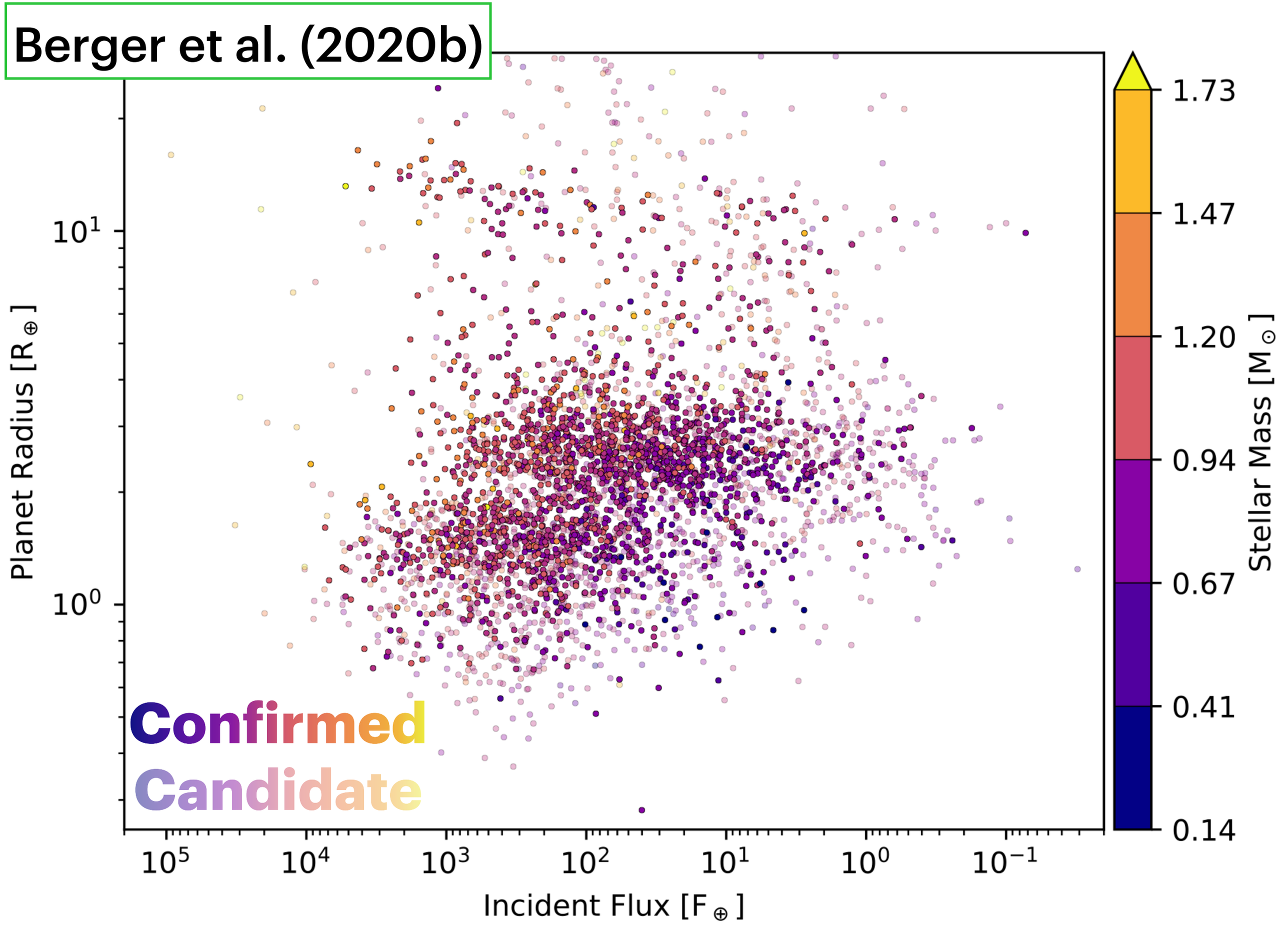
Berger et al. (2020a)

Now that we have these shiny new stellar properties, what can we learn about planets?

Berger et al. (2020b)



Berger et al. (2020b)



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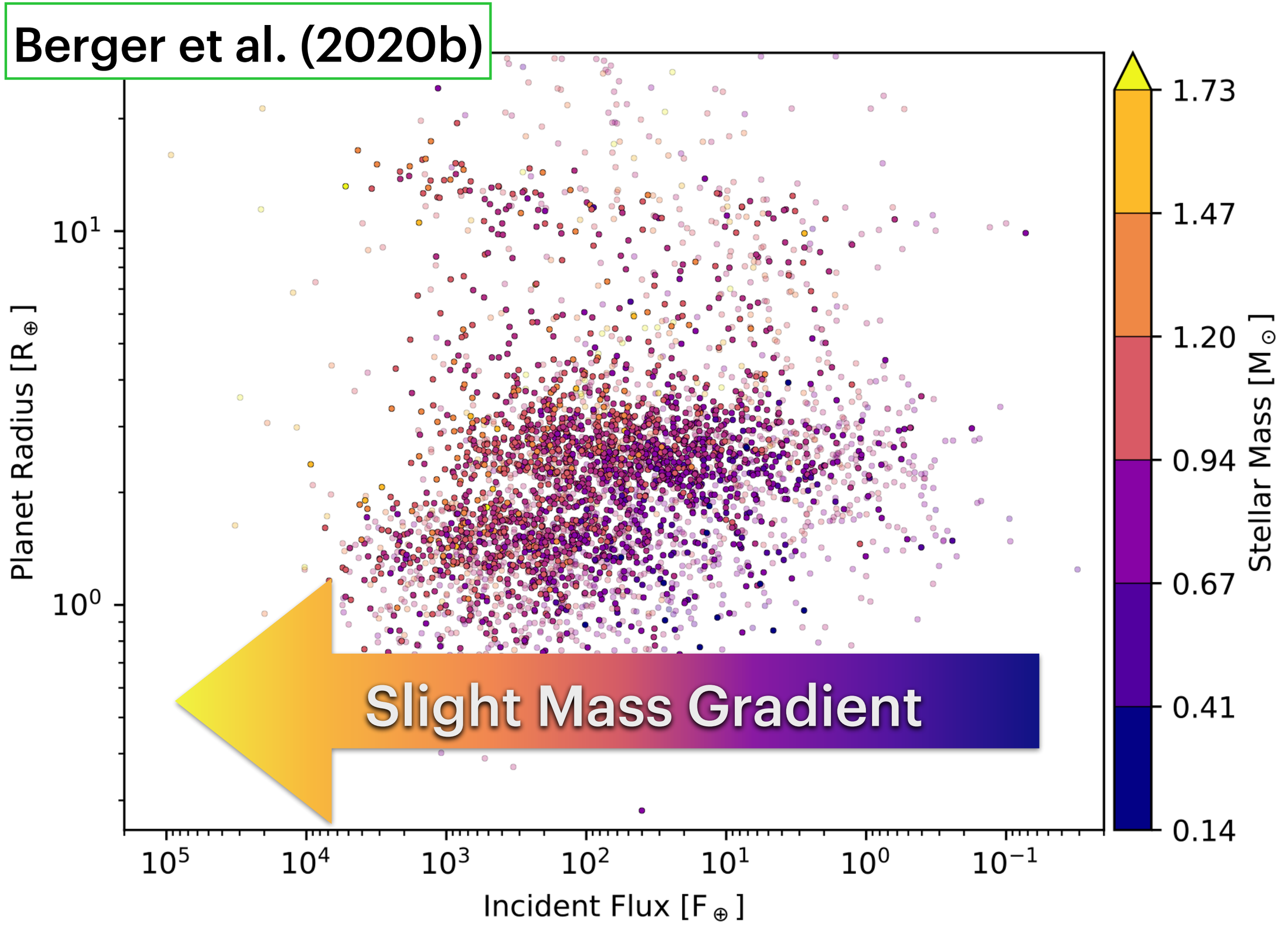

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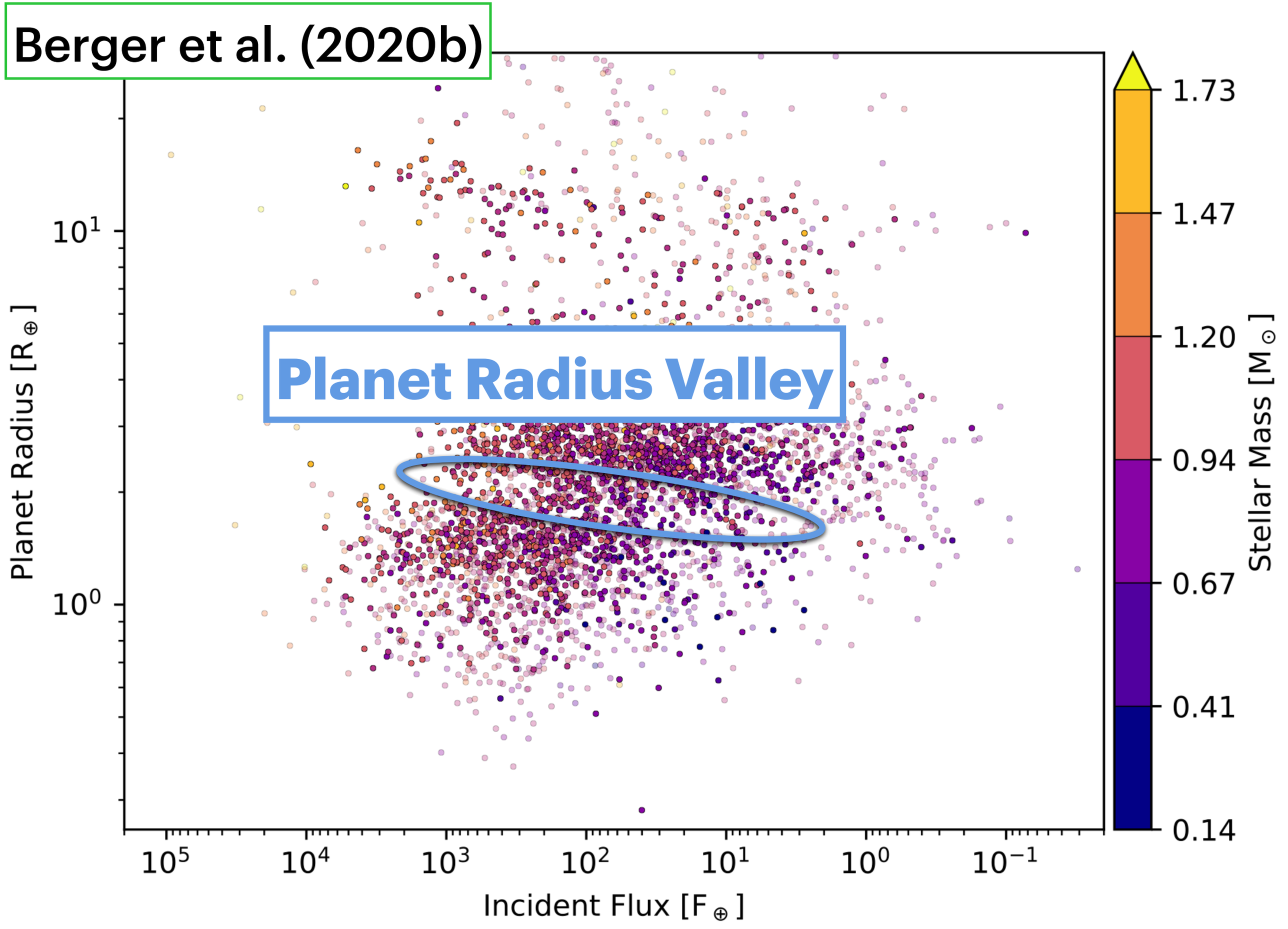

How does the planet radius valley depend on stellar age?

Berger et al. (2020b)

Old Planets
(> 1 Gyr)

Number of Planets

0
2
4
6
8
10
12

0.5
1
2
5
10
20

Planet Radius [$R_\oplus$]

Berger et al. (2020b)

Old Planets
(> 1 Gyr)

Super-
Earths

Sub-
Neptunes

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$N_{\text{supEarth}}/N_{\text{subNep}}$:

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Gyr
Timescales

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Planet Radius [$R_\oplus$]

Summary/Conclusions

- The Gaia-Kepler Stellar Properties Catalog (Berger et al. 2020a) has a median fractional radius precision of ~4%, compared to 25% for the previous Kepler Catalog.

- We validated our isochrone ages (median catalog fractional uncertainty ~56%) with cluster and aster-seismic comparisons, which agree within reported uncertainties.

- We find first evidence for the planet radius gap's dependence on stellar age on timescales of a Gyr.