Precise Characterization of *Kepler* Stars and Planets Using *Gaia* DR2

Travis Berger

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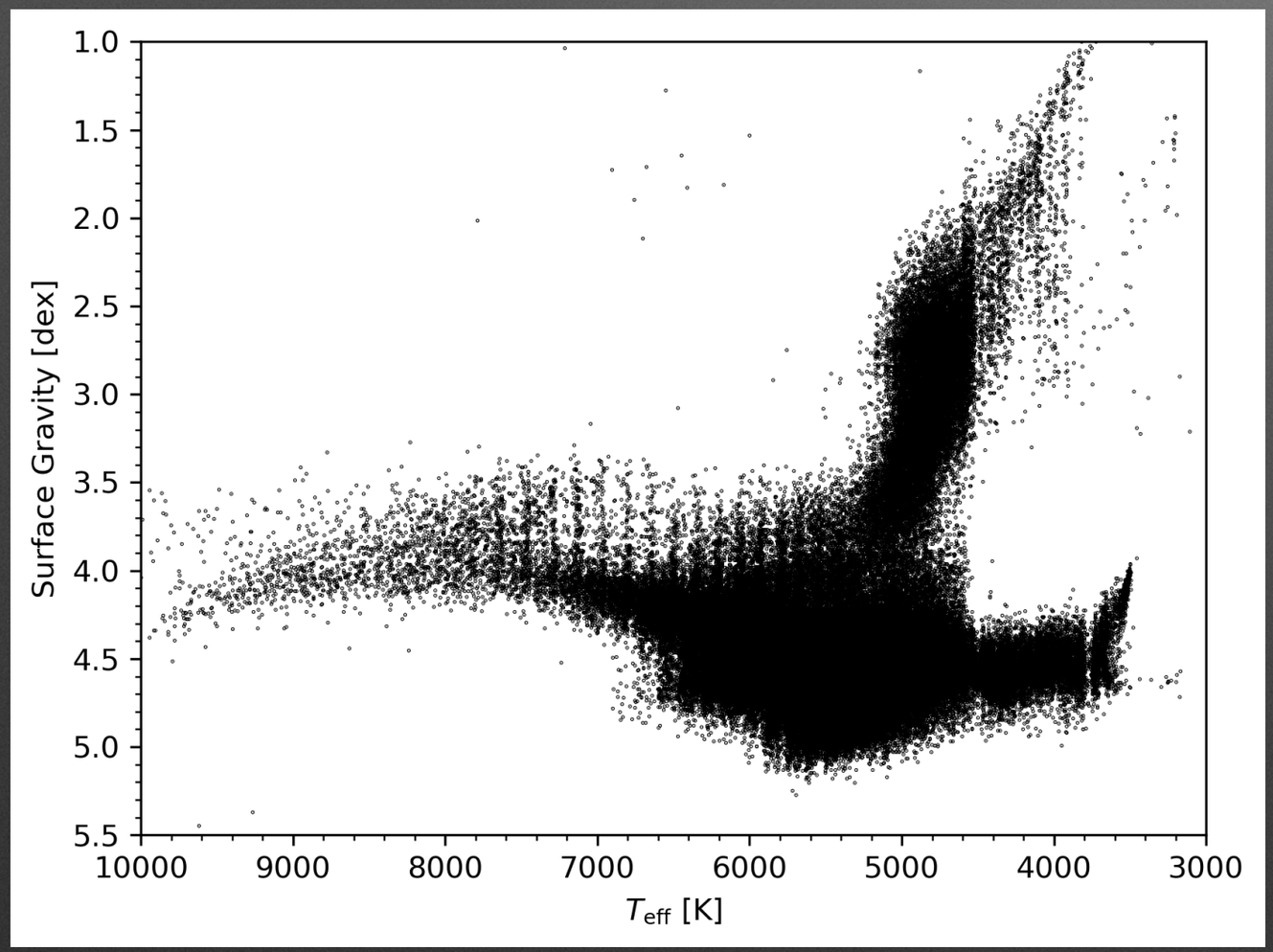
@taberger

The Evolution of *Kepler* Stellar Properties

The *Kepler* Input Catalog



Brown et al. (2011)

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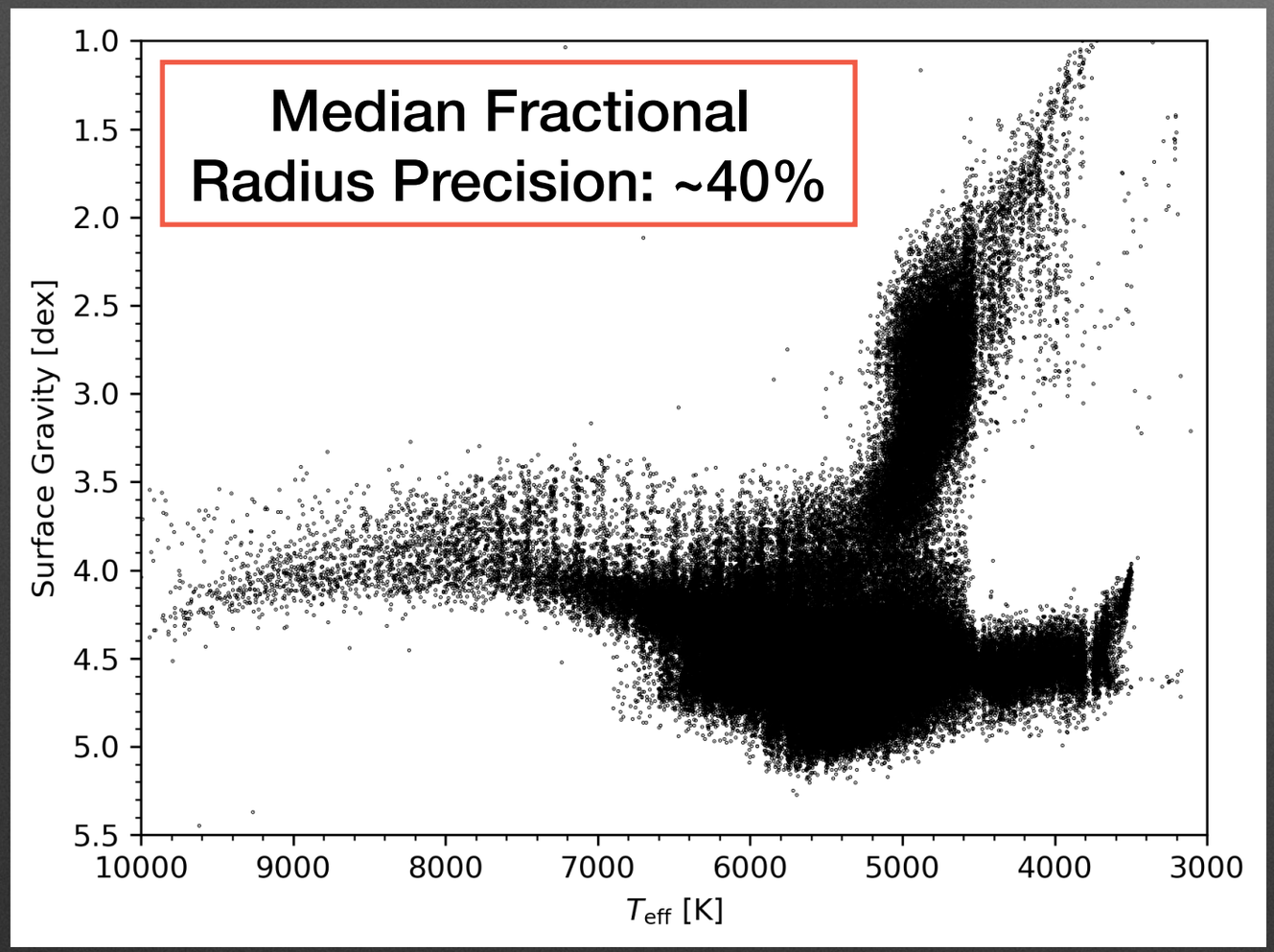

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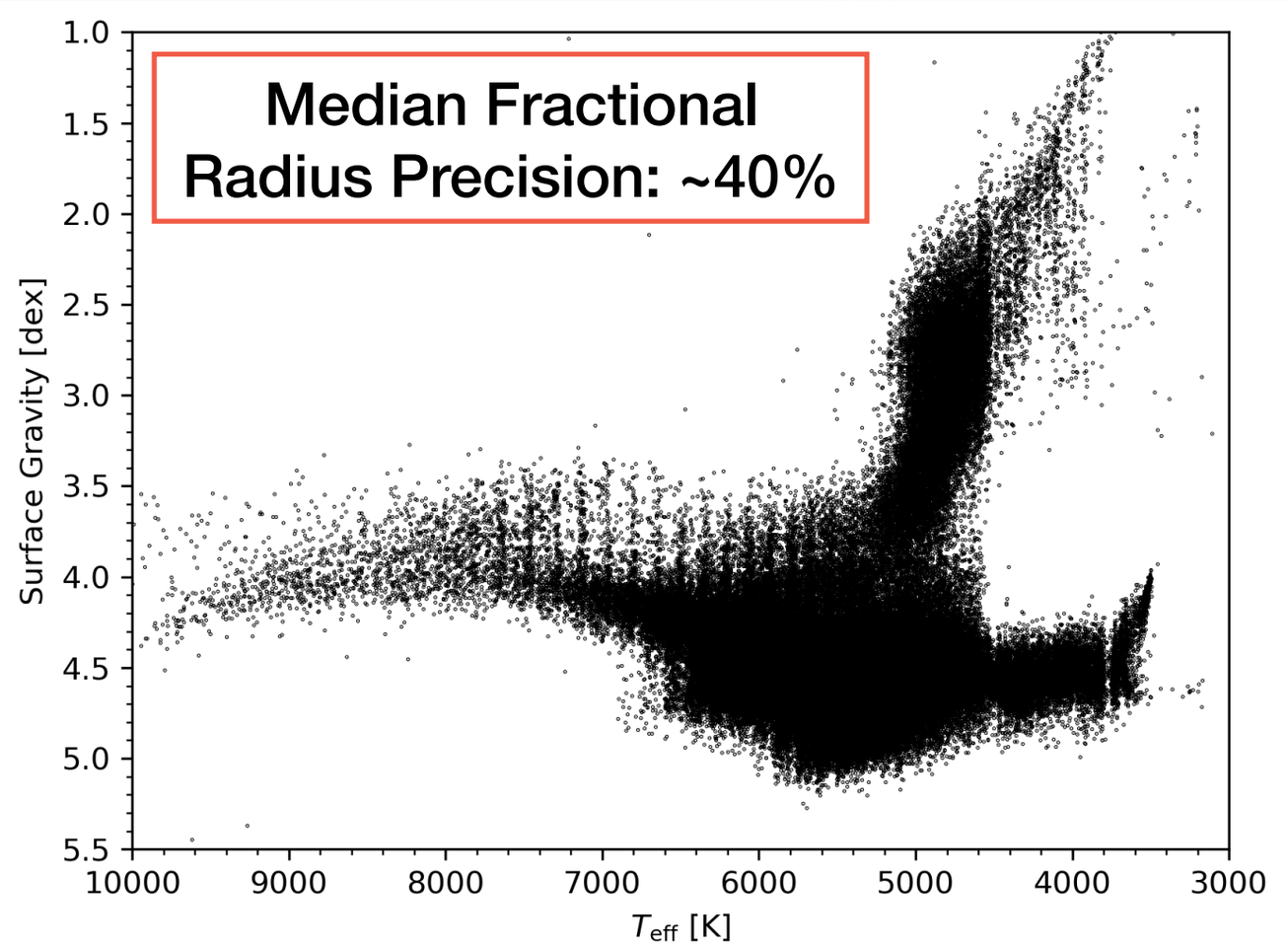
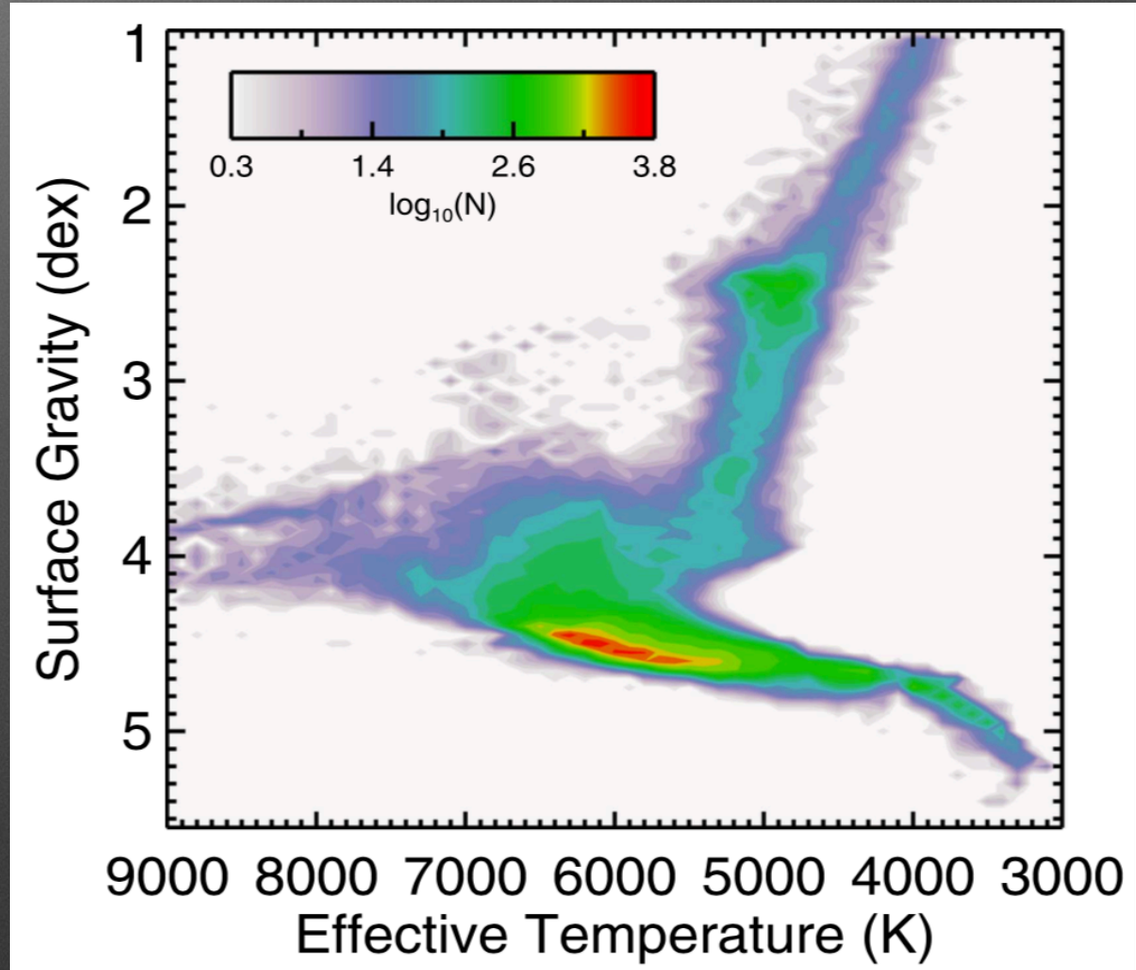


Brown et al. (2011)

The *Kepler* Stellar Properties Catalog



Mathur et al. (2017)

The Evolution of *Kepler* Stellar Properties

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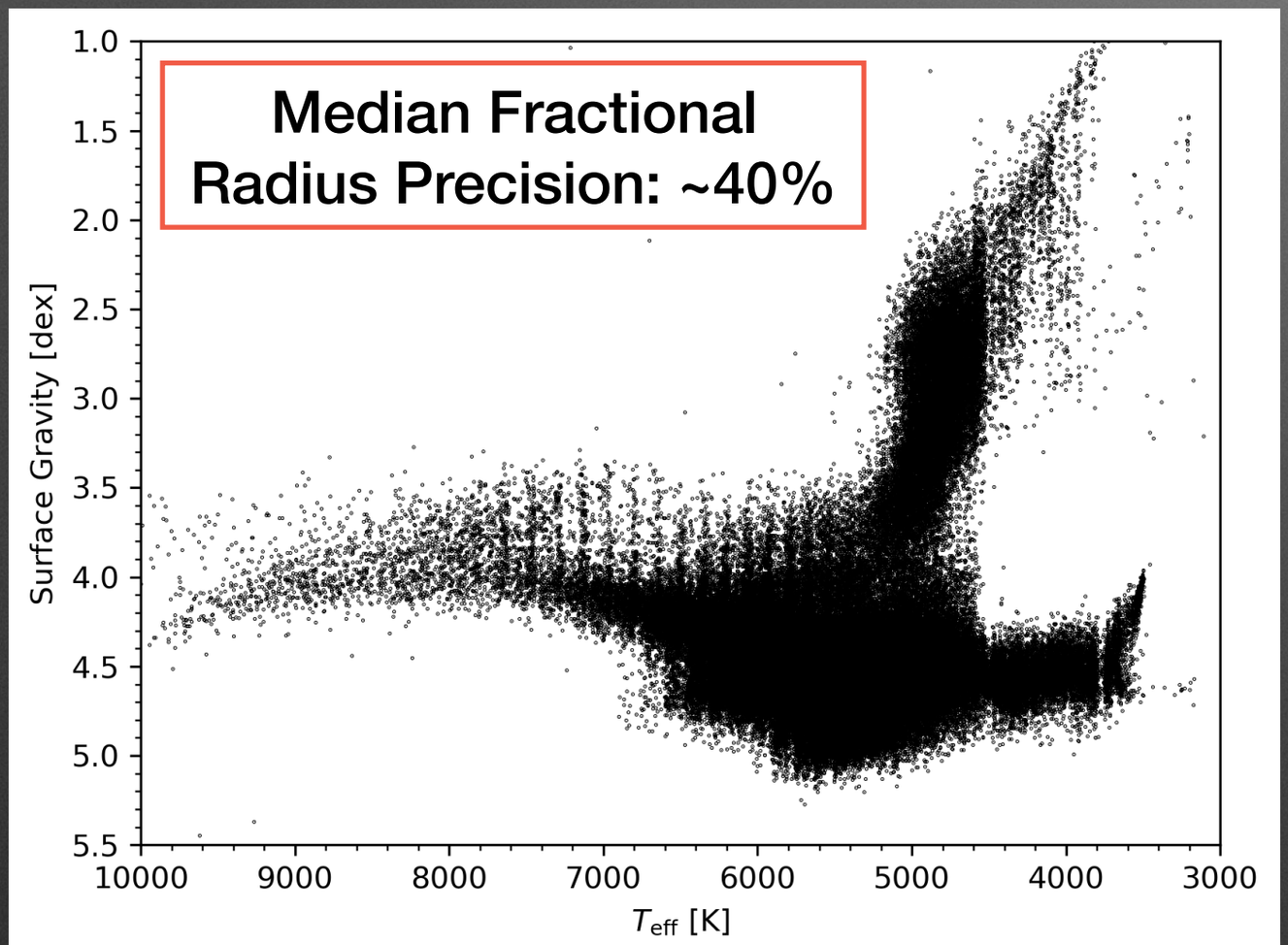

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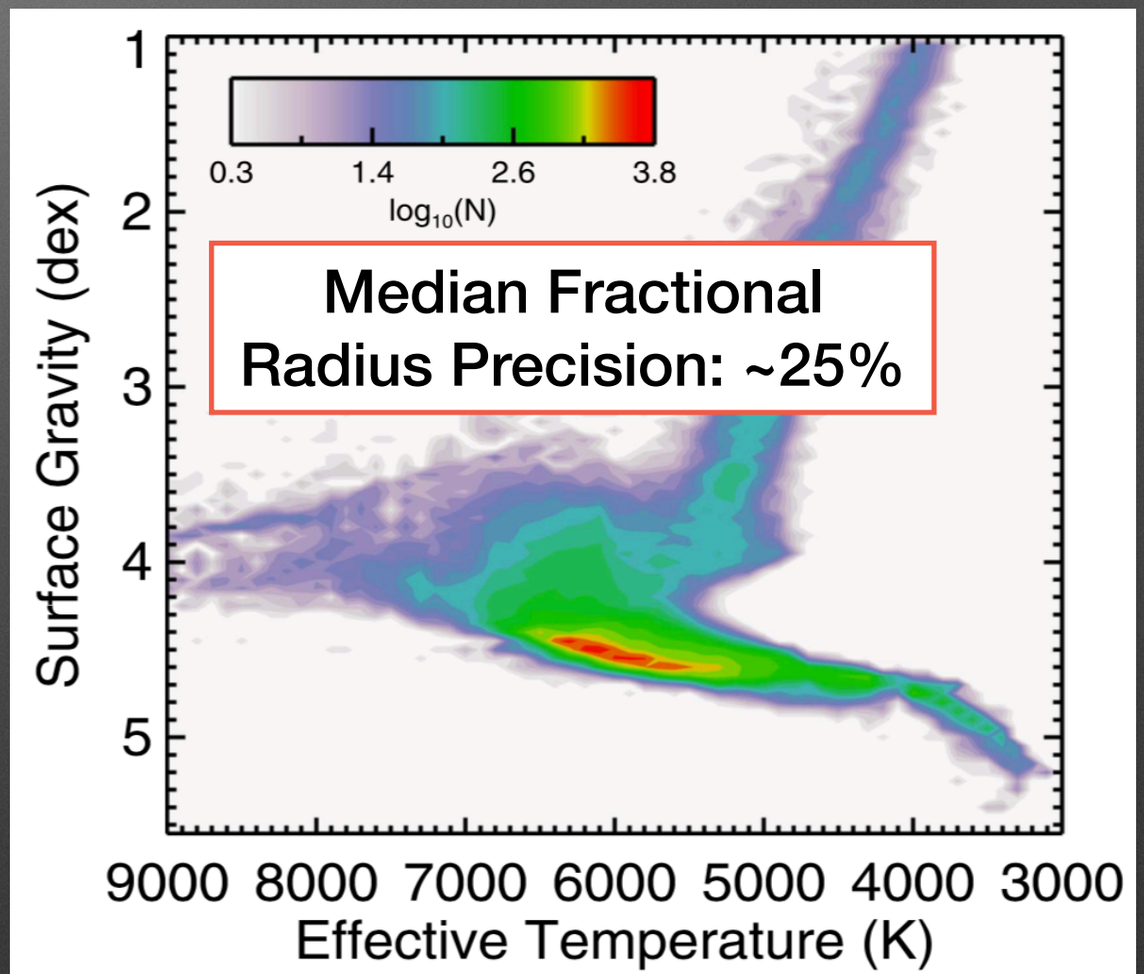
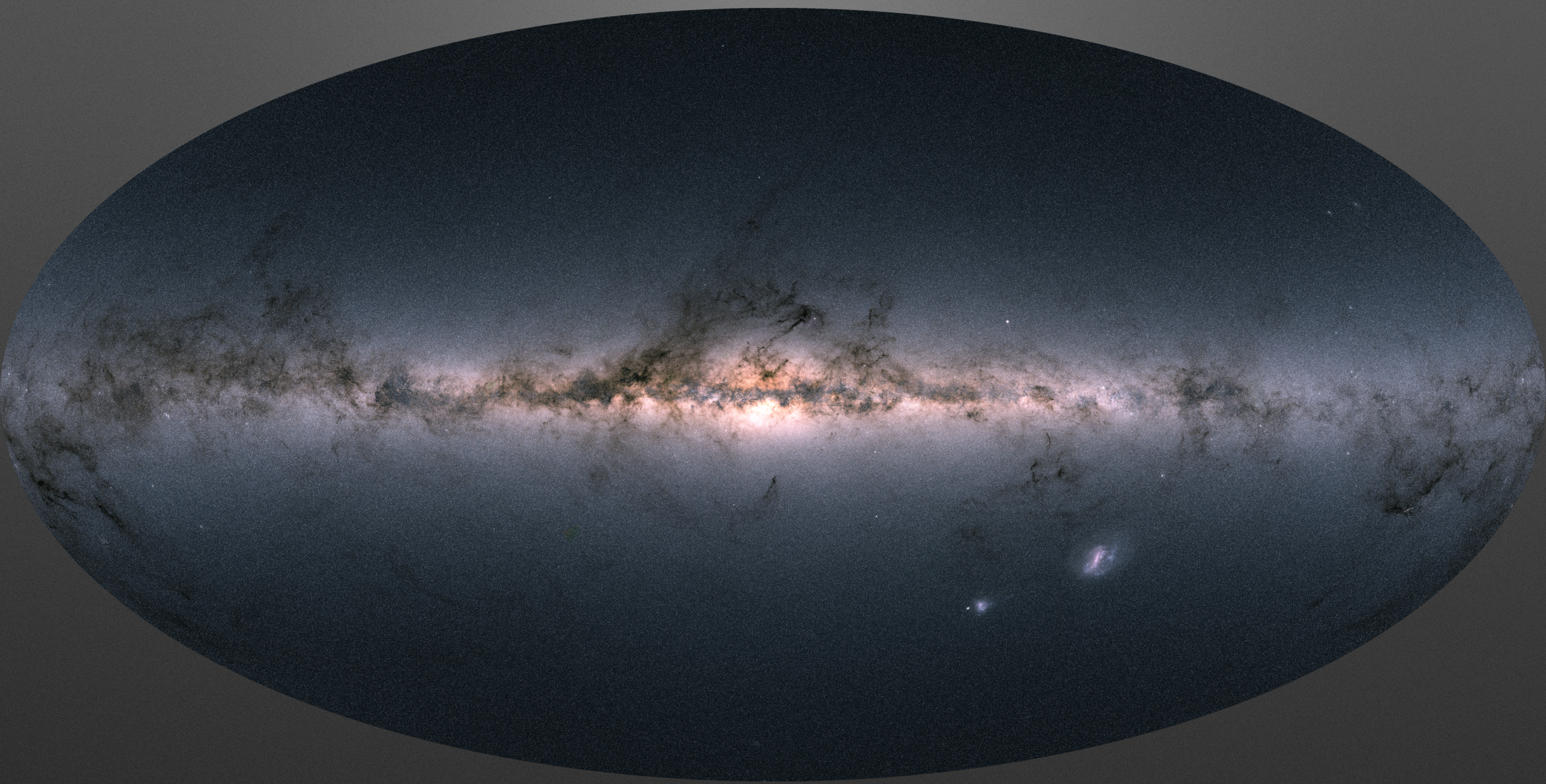


Mathur et al. (2017)

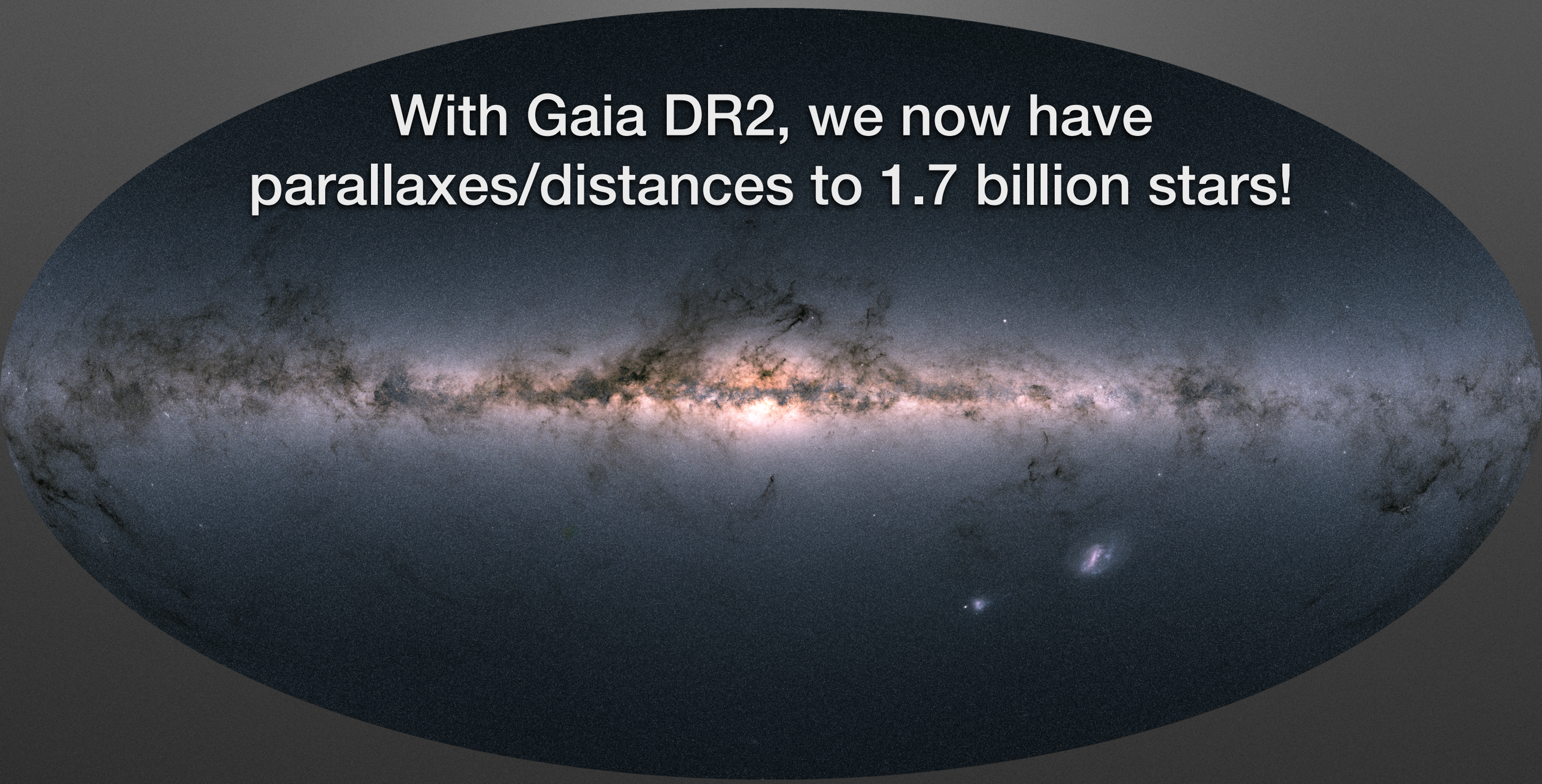
The *Gaia* DR2 Revolution



Credits: ESA/Gaia/DPAC, A. Moitinho / A. F. Silva / M. Barros / C. Barata, University of Lisbon, Portugal; H. Savietto, Fork Research, Portugal.

The *Gaia* DR2 Revolution

With Gaia DR2, we now have
parallaxes/distances to 1.7 billion stars!



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$$R_\star = \sqrt{\frac{F_{\rm bol} d^2}{\sigma T_{\rm eff}^4}}$$

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The *Gaia* DR2 Revolution

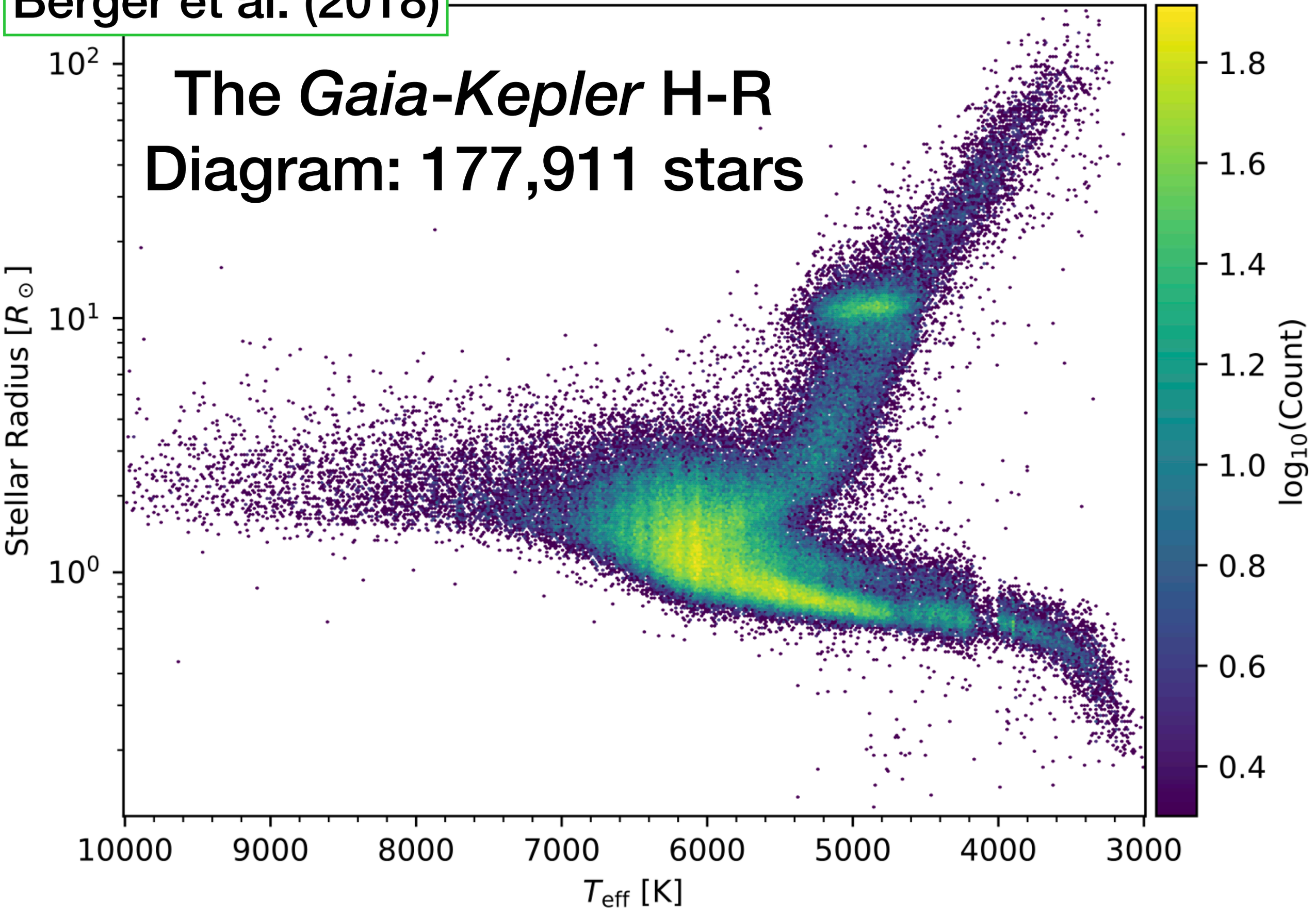
With Gaia DR2, we now have parallaxes/distances to 1.7 billion stars!

$$R_\star = \sqrt{\frac{F_{\rm bol} d^2}{\sigma T_{\rm eff}^4}}$$

Finally constrained!

Credits: ESA/Gaia/DPAC, A. Moitinho / A. F. Silva / M. Barros / C. Barata, University of Lisbon, Portugal; H. Savietto, Fork Research, Portugal.

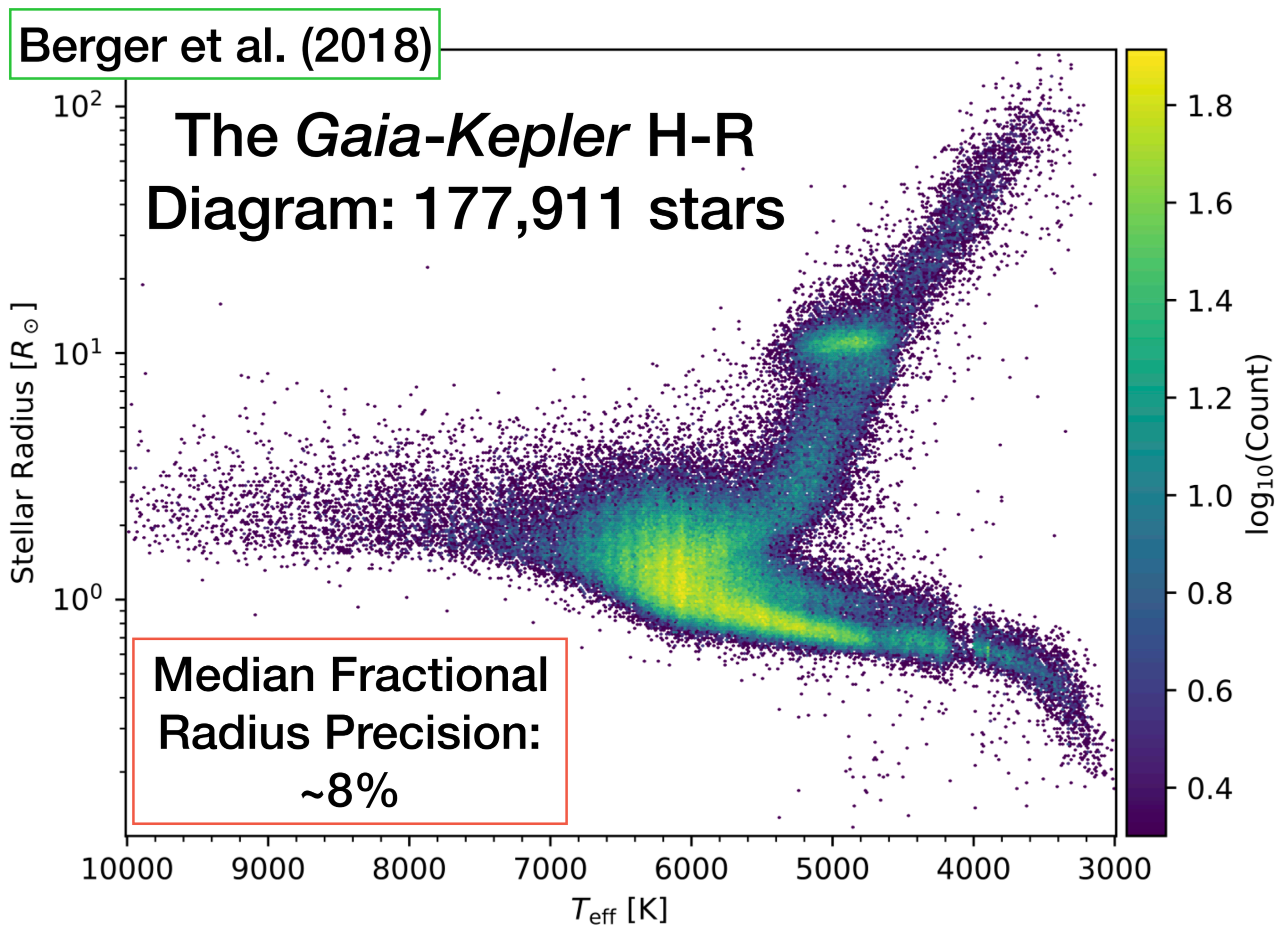
Berger et al. (2018)



Berger et al. (2018)

The *Gaia-Kepler* H-R Diagram: 177,911 stars

Median Fractional Radius Precision: ~8%



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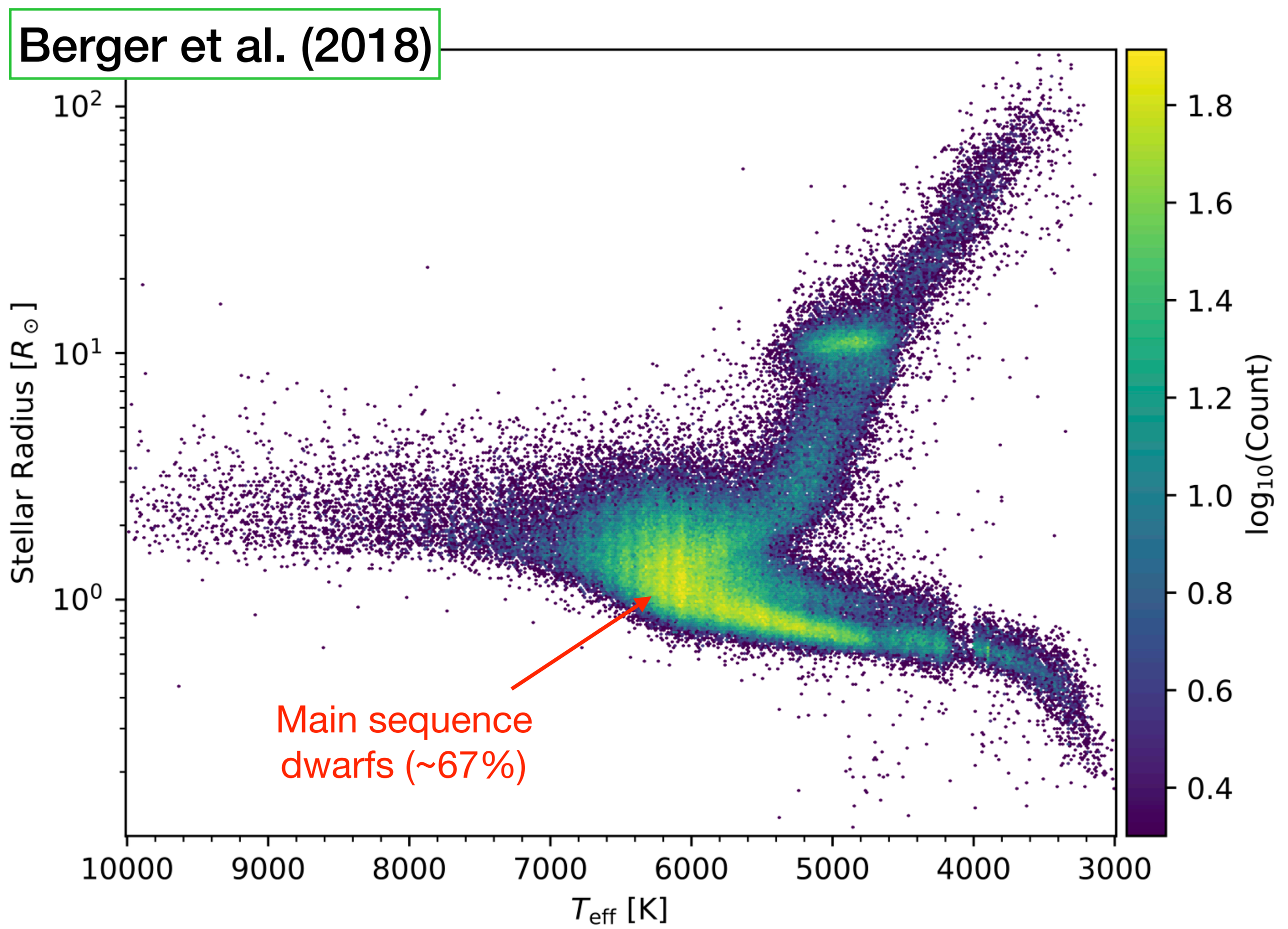
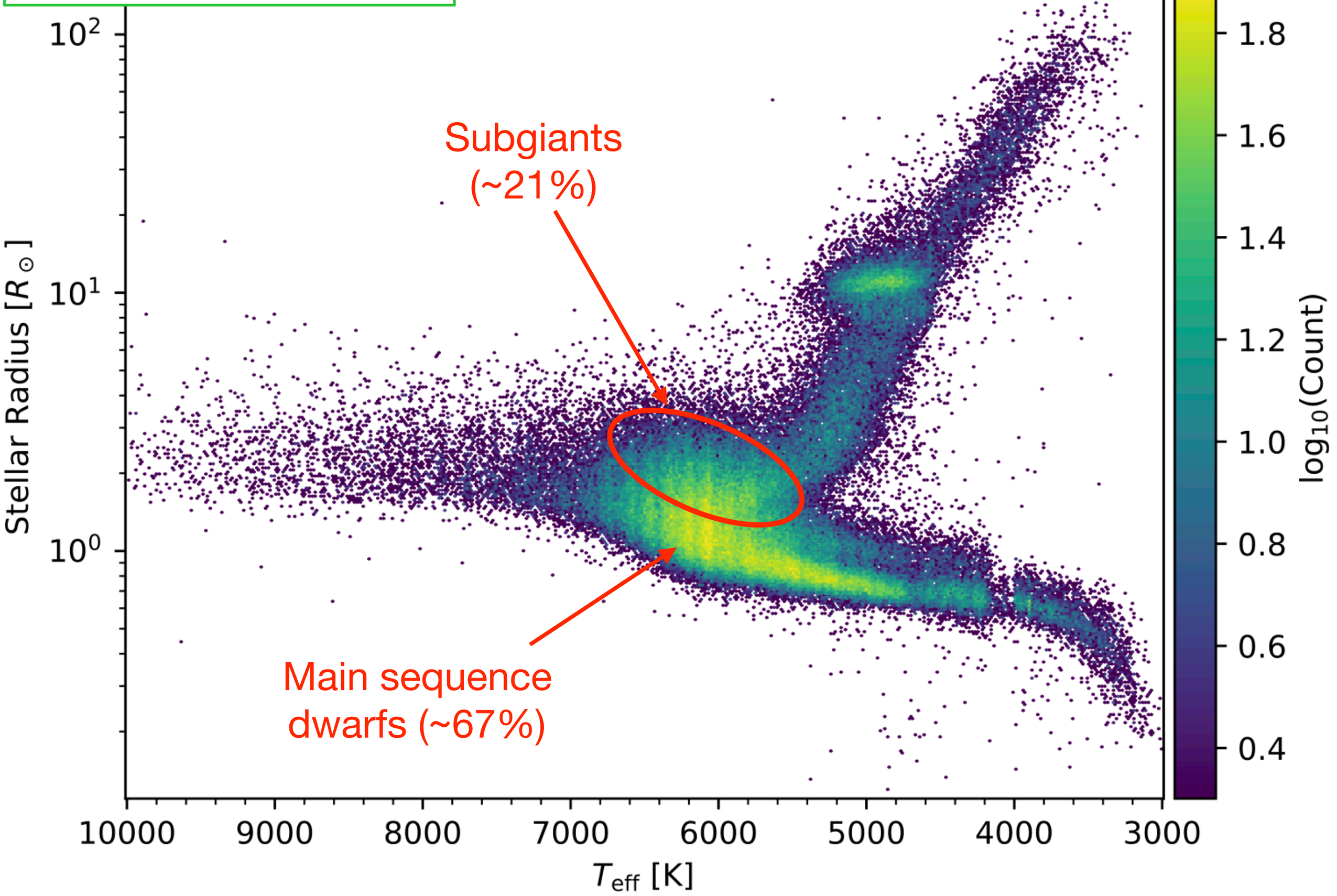
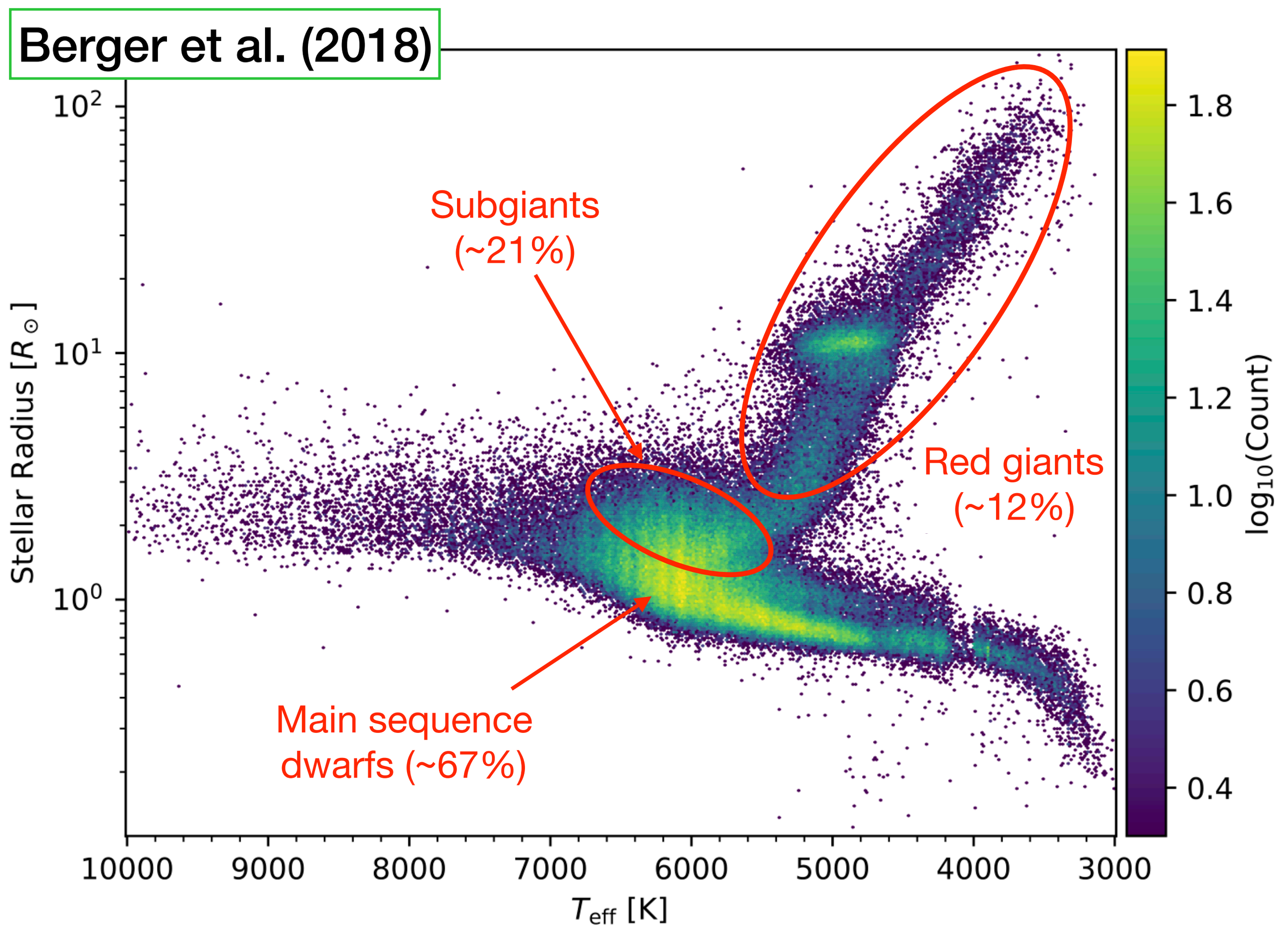


Berger et al. (2018)



Berger et al. (2018)



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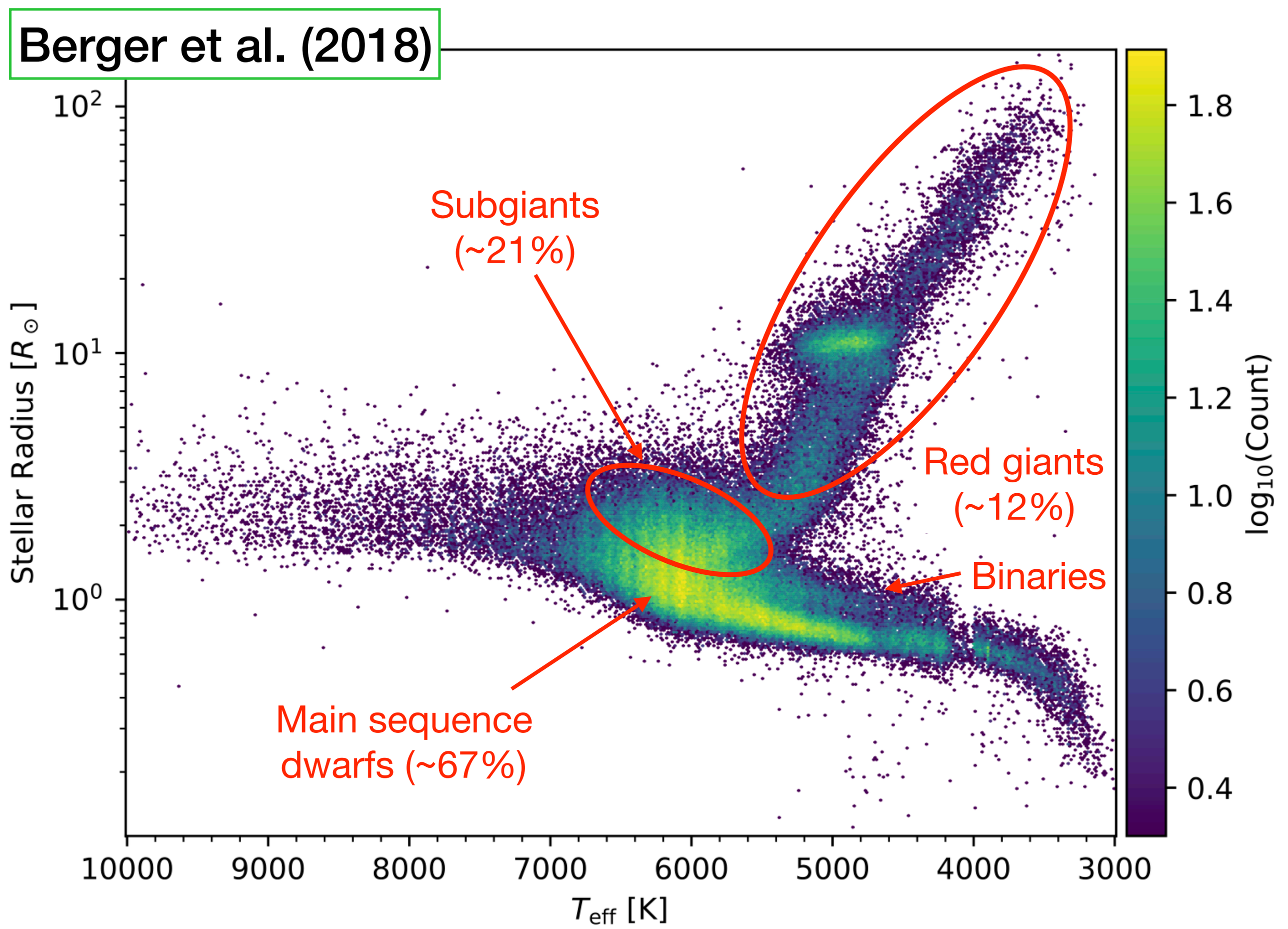

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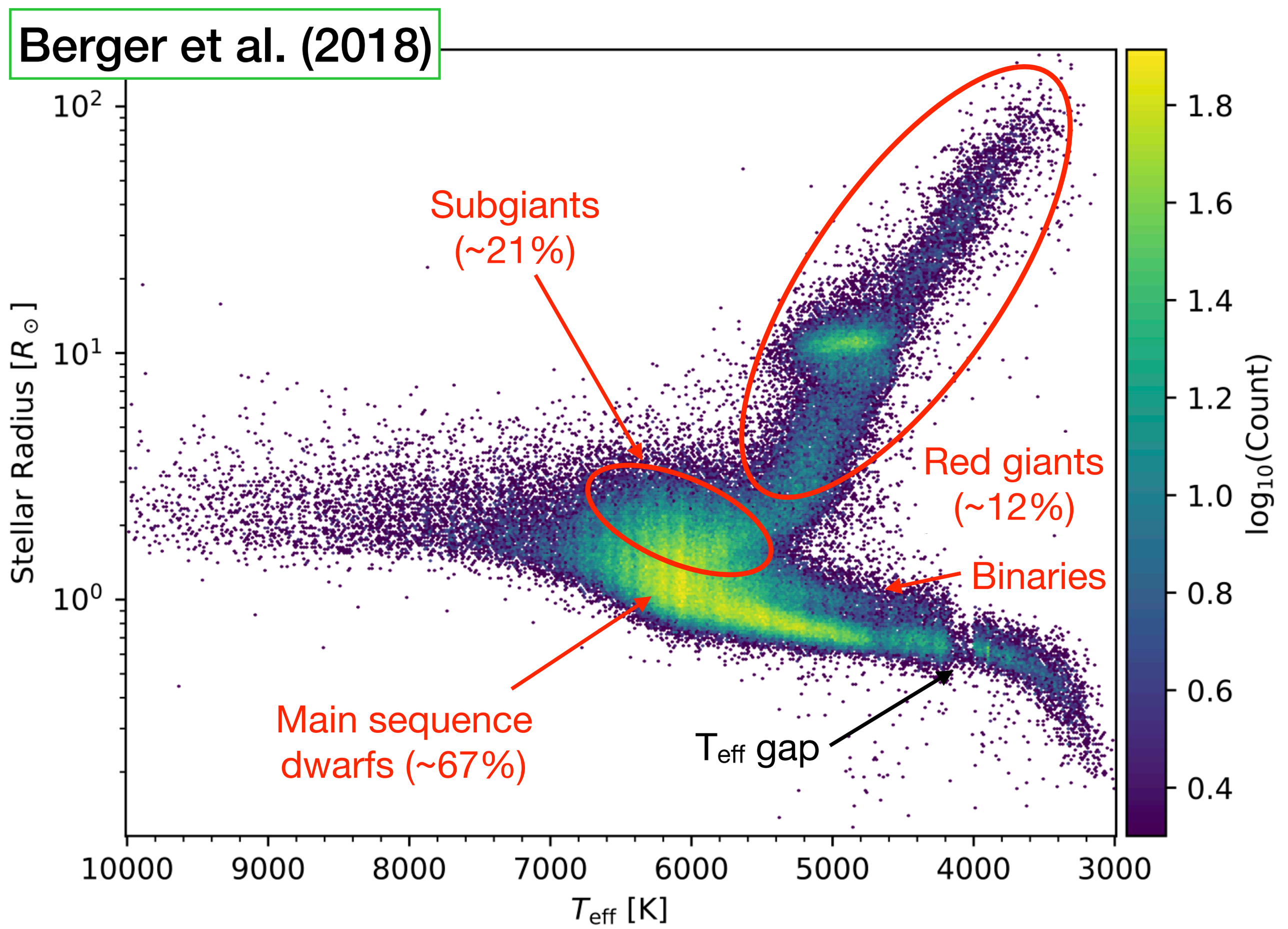


How do these revised stellar radii affect the properties of exoplanets?

Before

Confirmed Planets
Candidate Planets

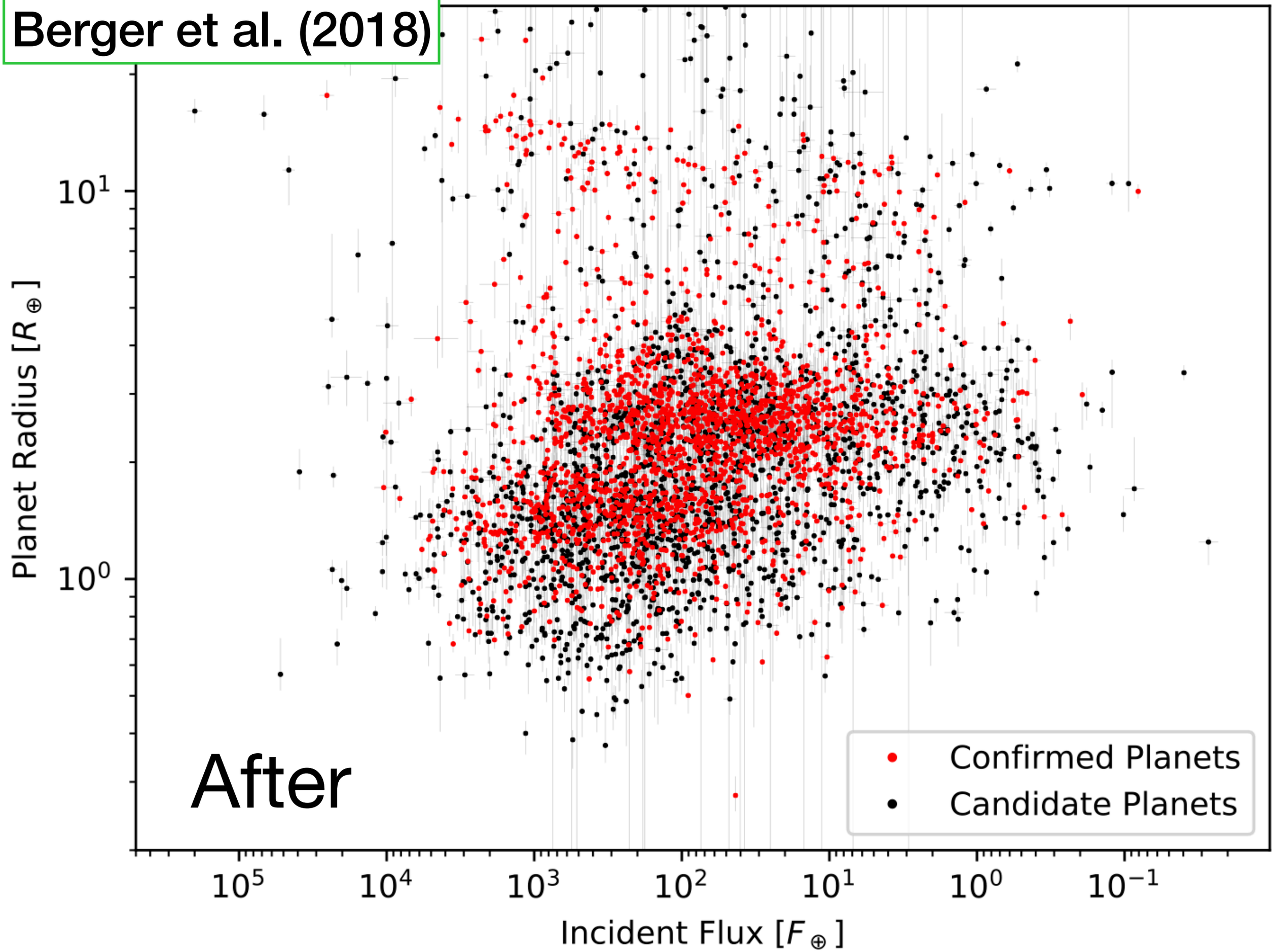
Planet Radius [$R_\oplus$]

10^1
10^0

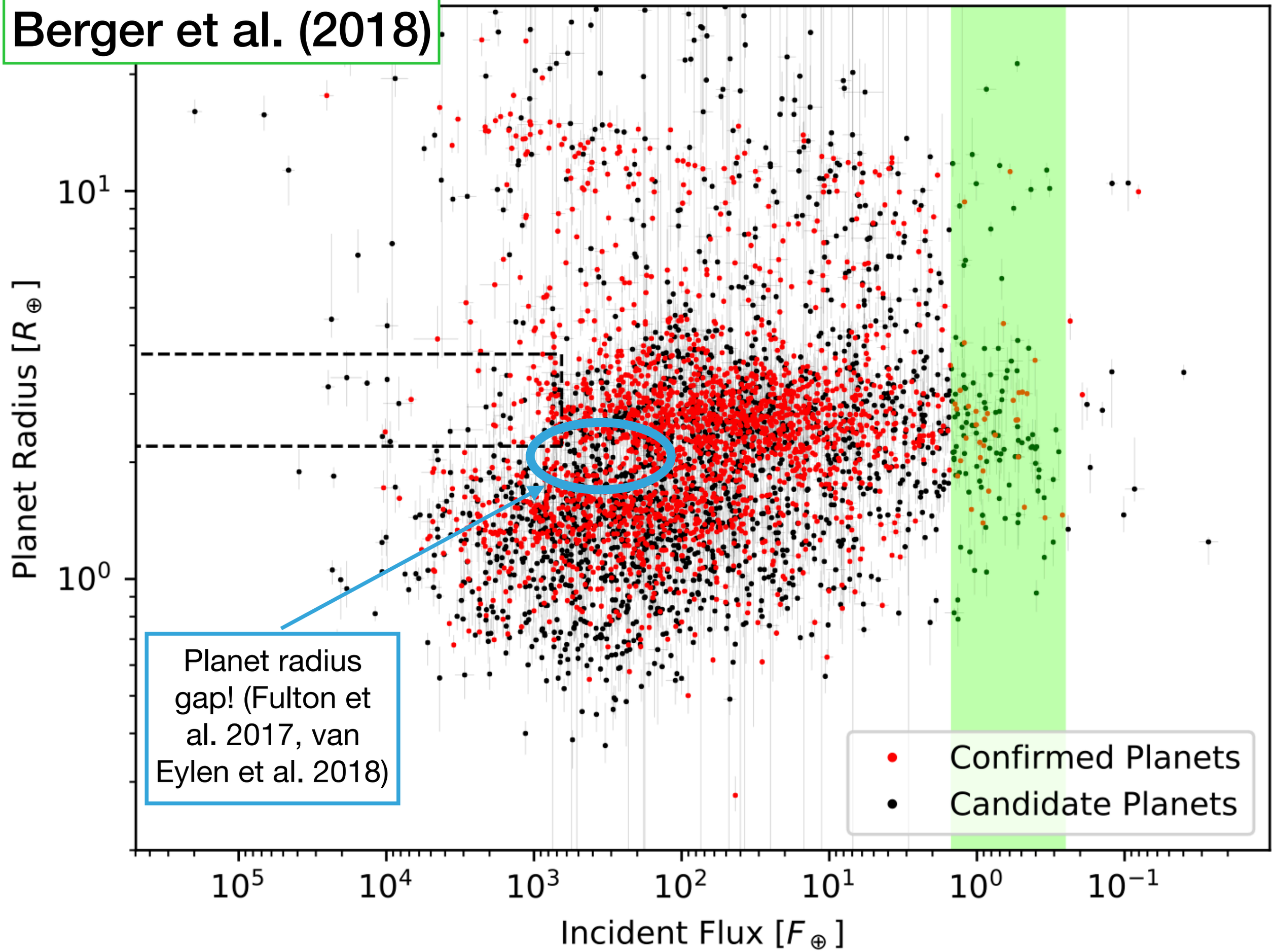
10^5 10^4 10^3 10^2 10^1 10^0 10^{-1}

Incident Flux [$F_\oplus$]

Berger et al. (2018)



Berger et al. (2018)



Berger et al. (2018)

74 planets found in the hot-super Earth desert! (Lundkvist et al. 2016)

Planet Radius [$R_\oplus$]

10^1

10^0

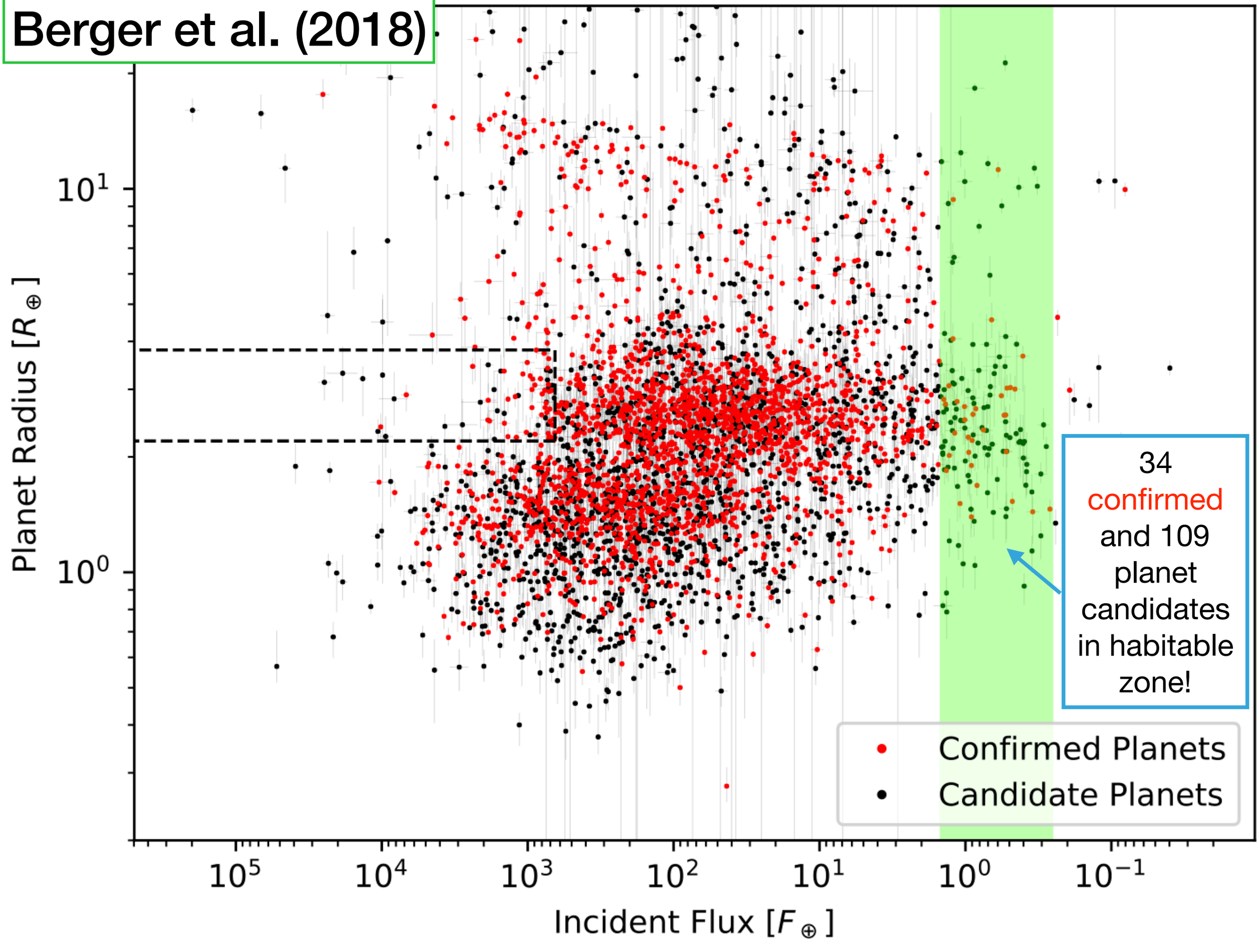
10^5 10^4 10^3 10^2 10^1 10^0 10^{-1}

Incident Flux [$F_\oplus$]

Confirmed Planets

Candidate Planets

Berger et al. (2018)



Berger et al. (2018)

Hot Jupiter inflation trend! (Miller & Fortney 2011, Grunblatt et al. 2017)

Planet Radius [$R_\oplus$]

10^1

10^0

10^5 10^4 10^3 10^2 10^1 10^0 10^{-1}

Incident Flux [$F_\oplus$]

Confirmed Planets

Candidate Planets

Berger et al. (2018)

Cool, inflated Jupiters?

Confirmed Planets
Candidate Planets

Planet Radius [$R_\oplus$]

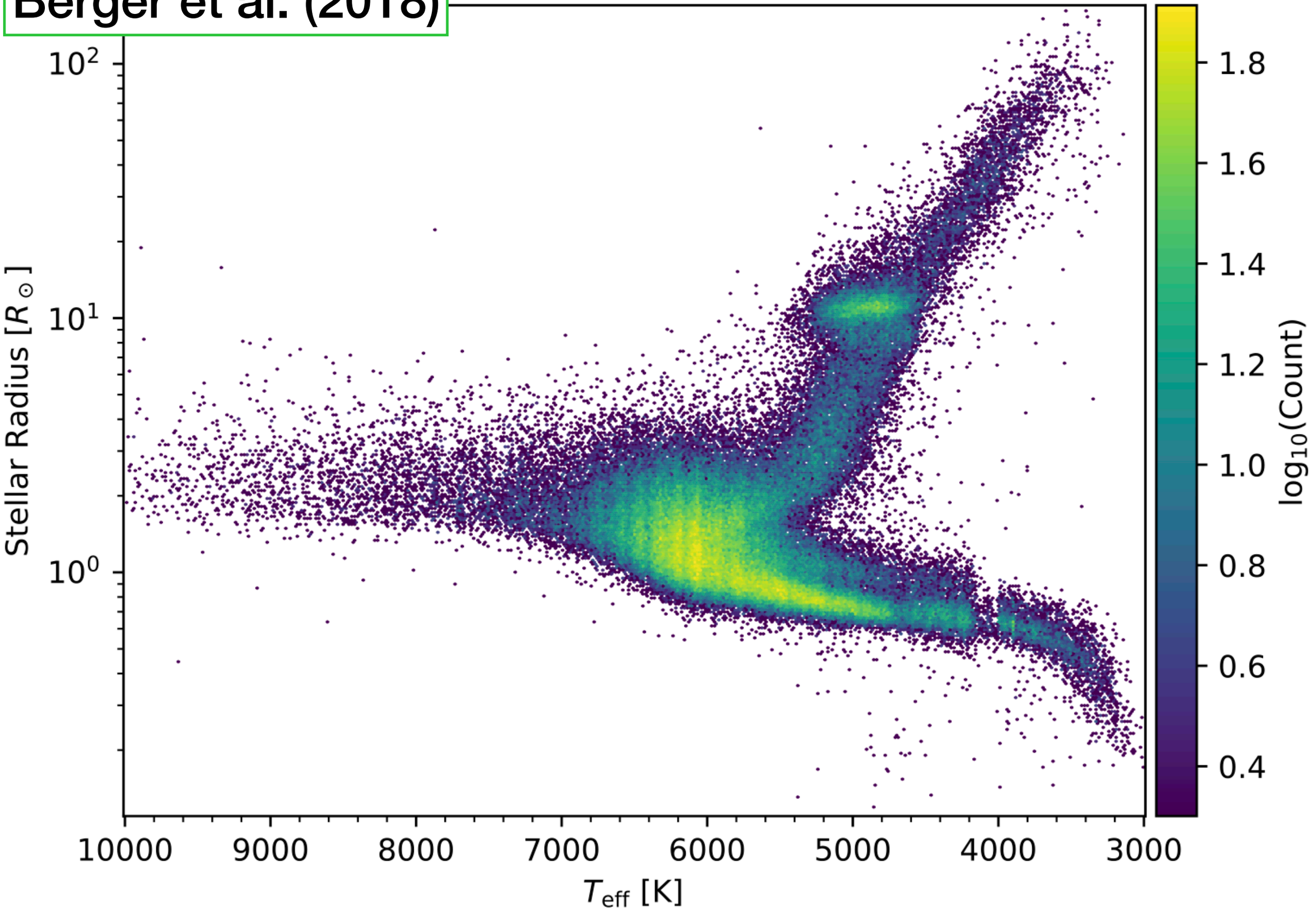
10^1
10^0

10^5 10^4 10^3 10^2 10^1 10^0 10^{-1}

Incident Flux [$F_\oplus$]

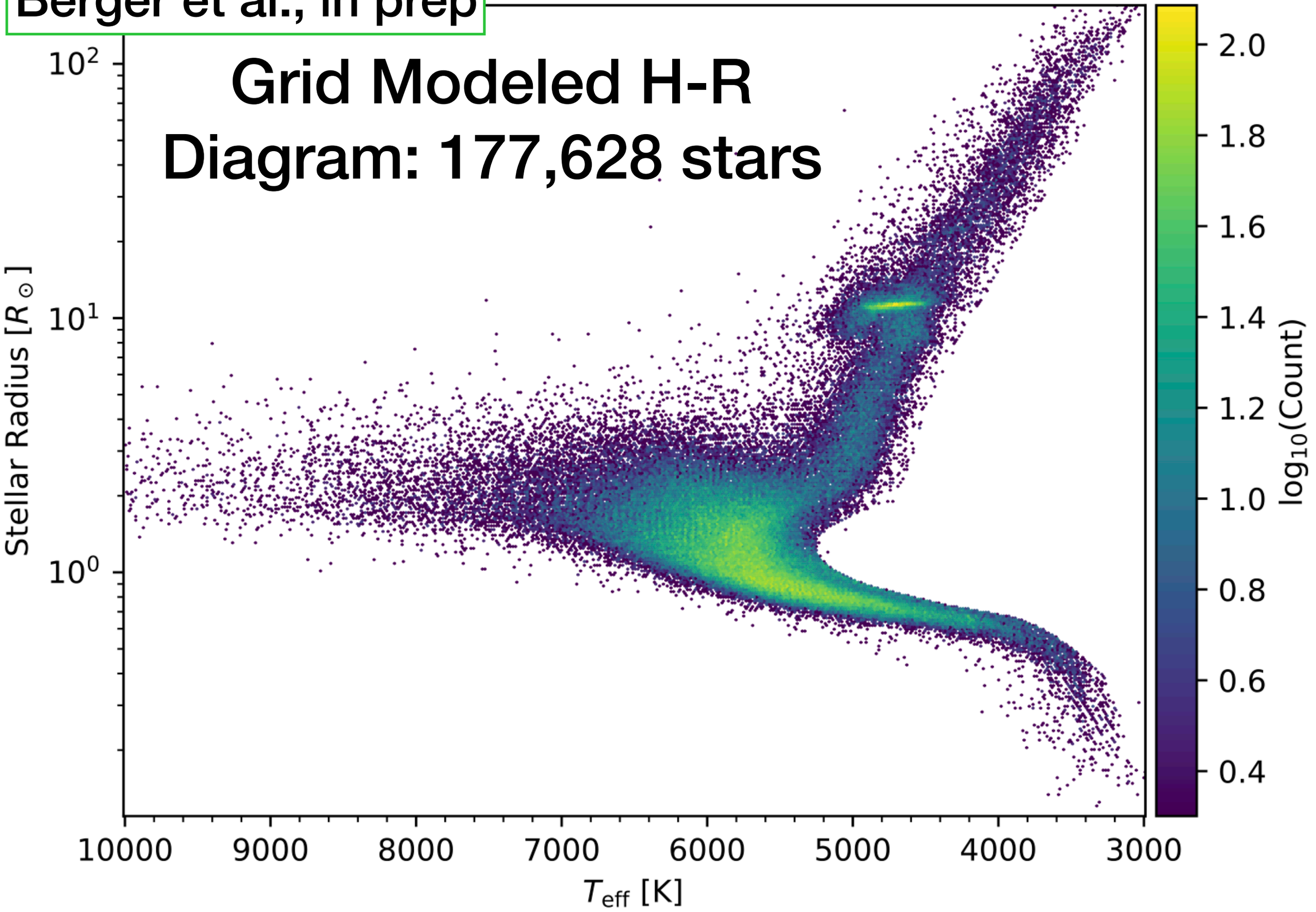
Revised radii are great, but we also want to know the masses and ages of *Kepler* stars!

Berger et al. (2018)



Berger et al., in prep

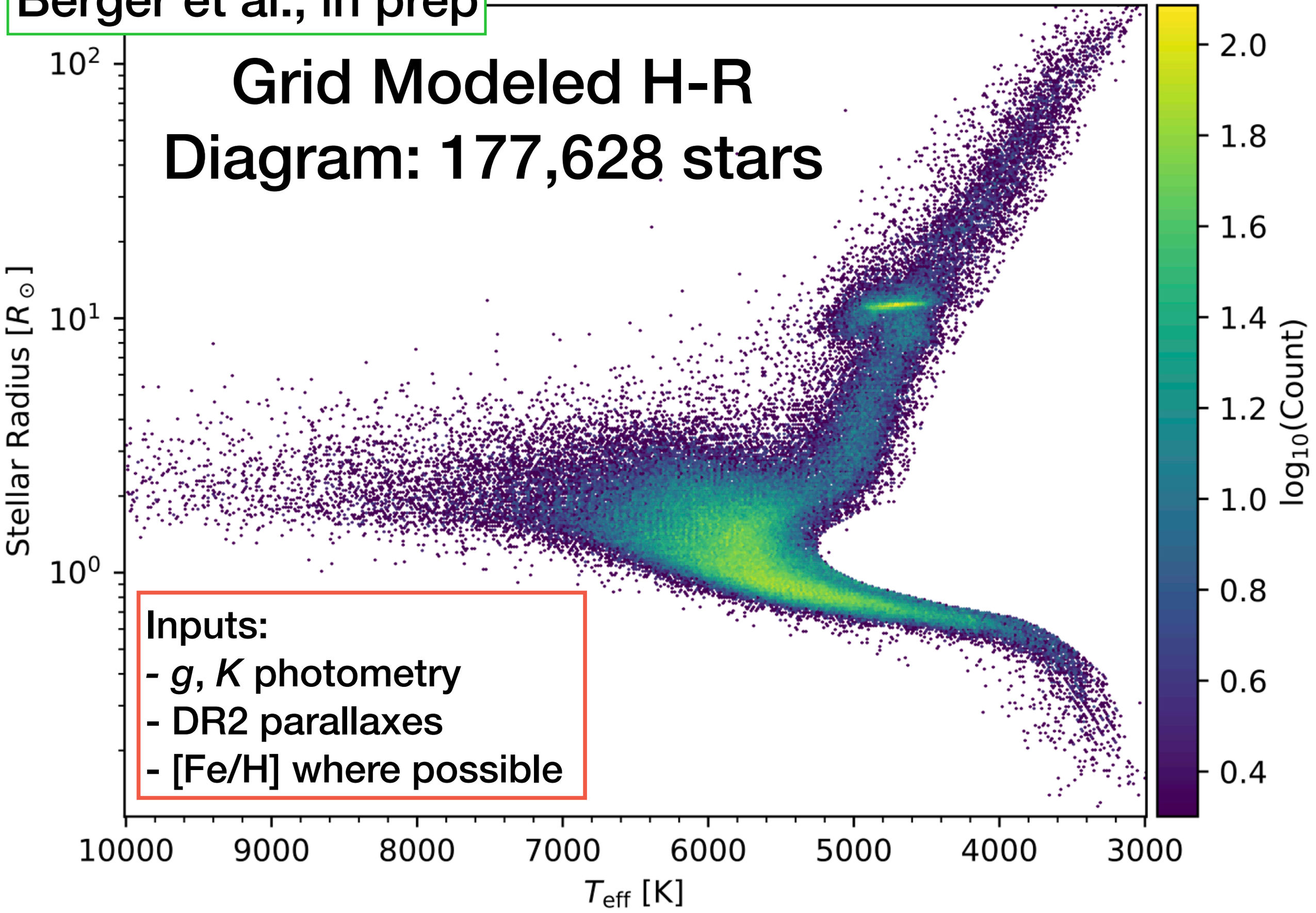
Grid Modeled H-R Diagram: 177,628 stars



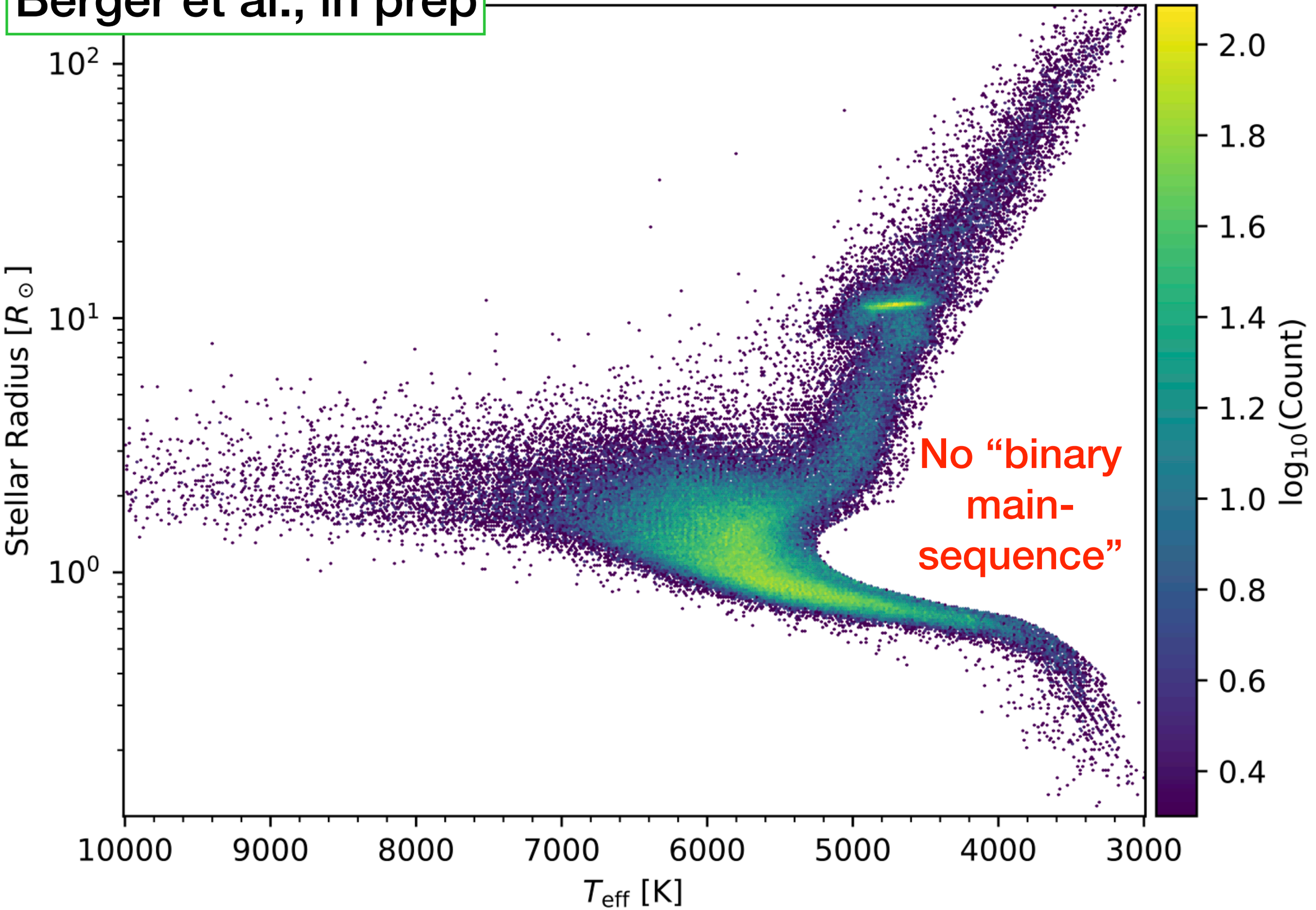
Berger et al., in prep

Grid Modeled H-R Diagram: 177,628 stars

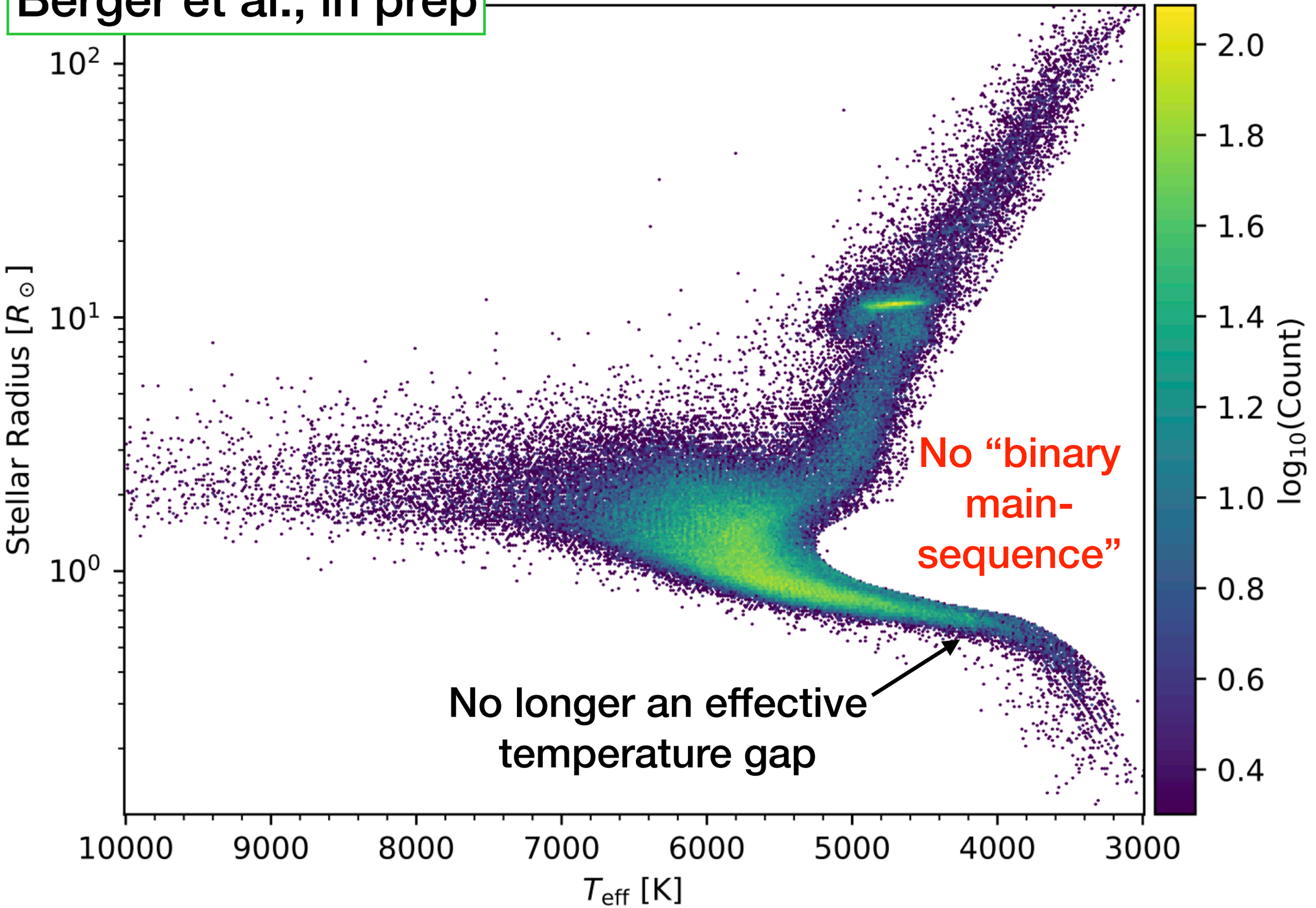
Inputs:
- *g*, *K* photometry
- DR2 parallaxes
- [Fe/H] where possible



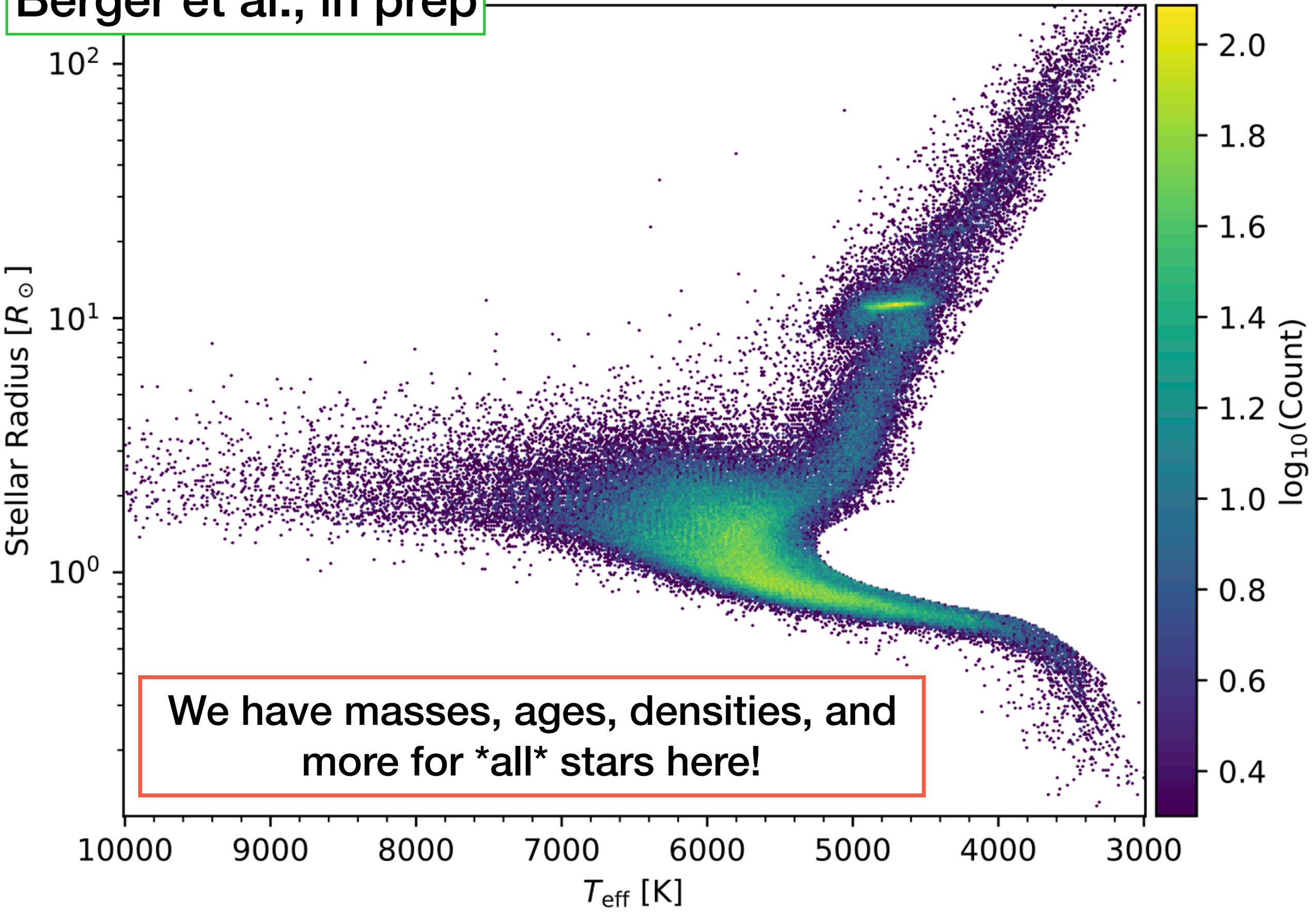
Berger et al., in prep



Berger et al., in prep

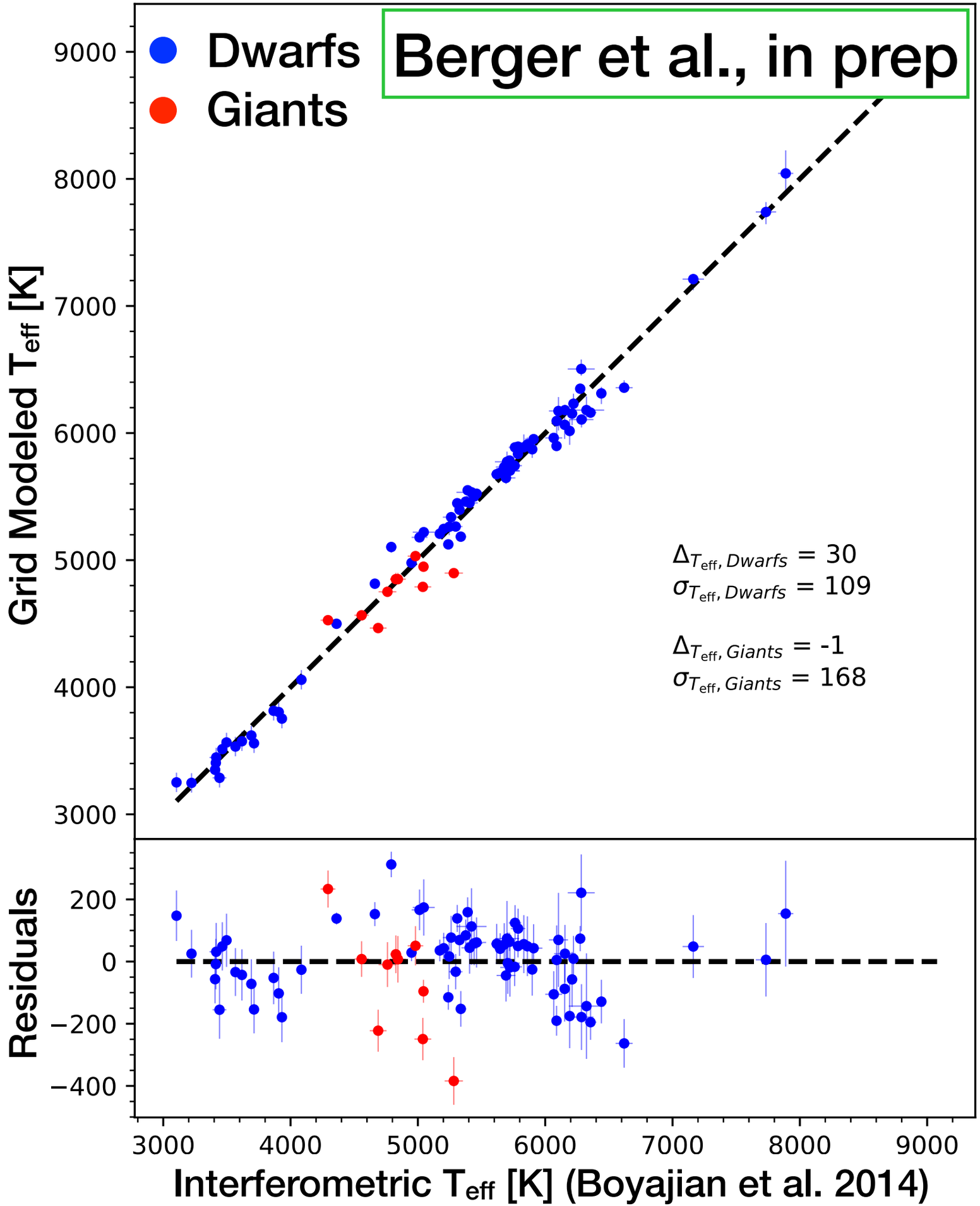


Berger et al., in prep



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

Interferometric calibration of effective temperatures



Berger et al. (2018)

Cool, inflated Jupiters?

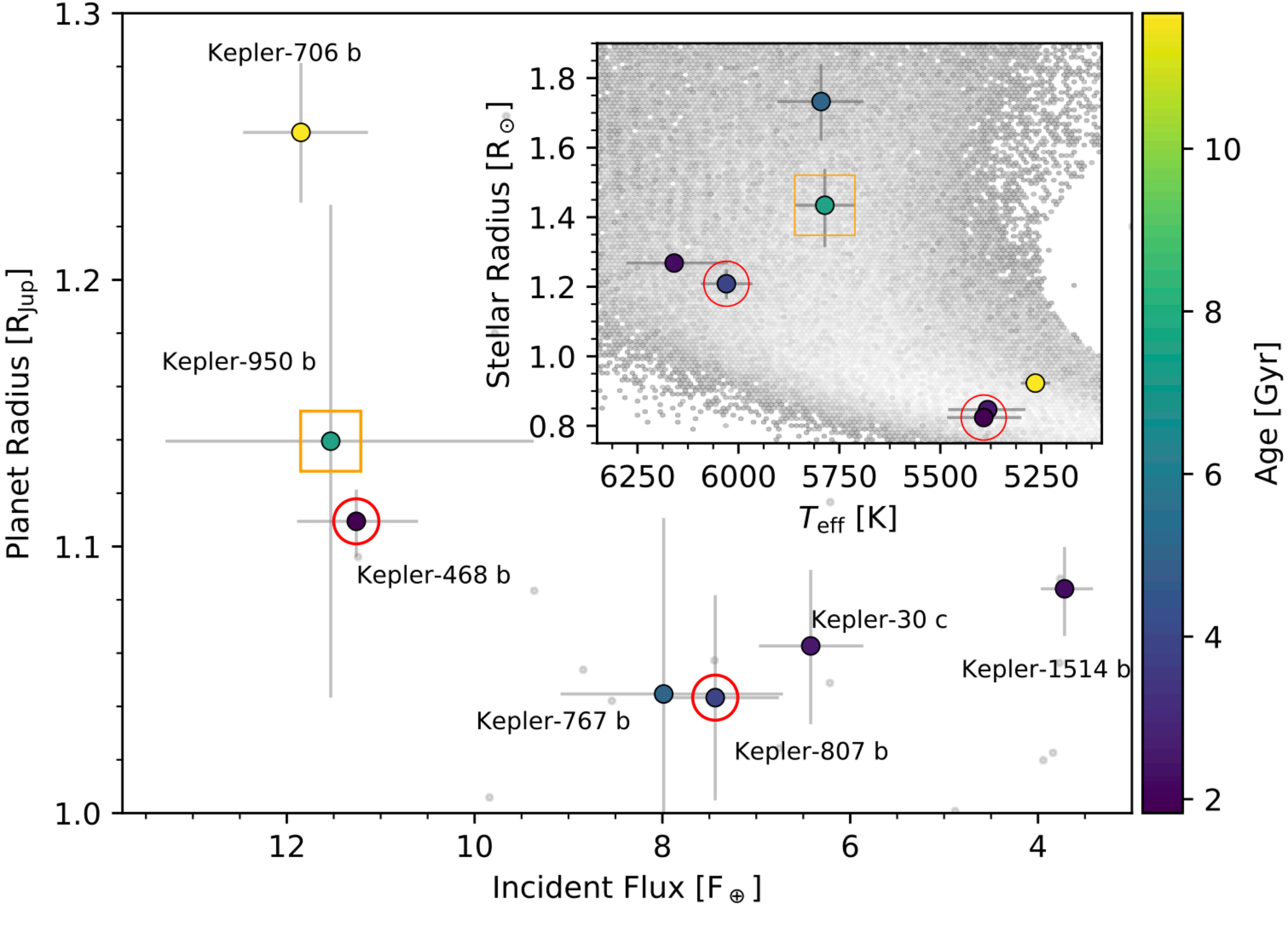
Confirmed Planets
Candidate Planets

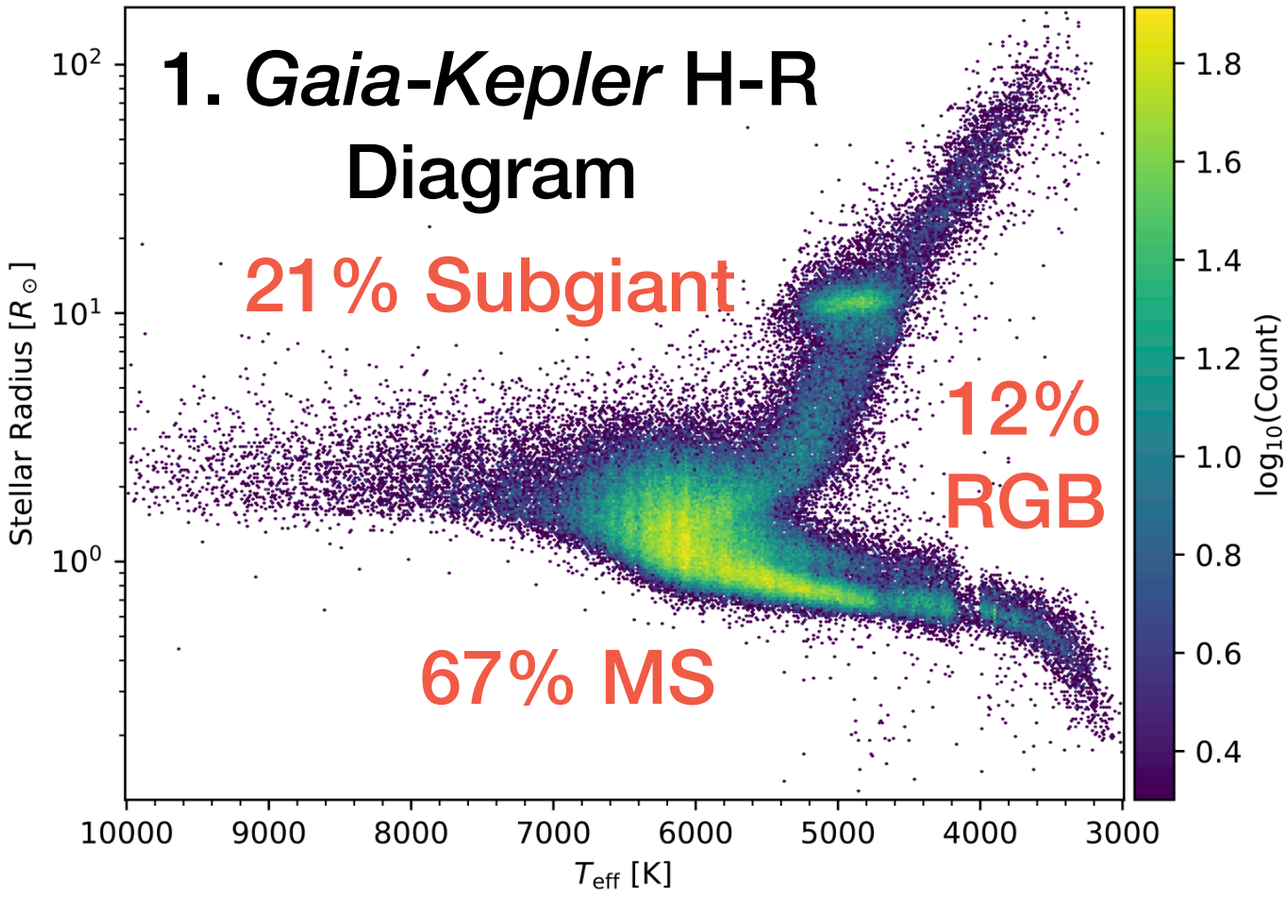
Planet Radius [$R_\oplus$]

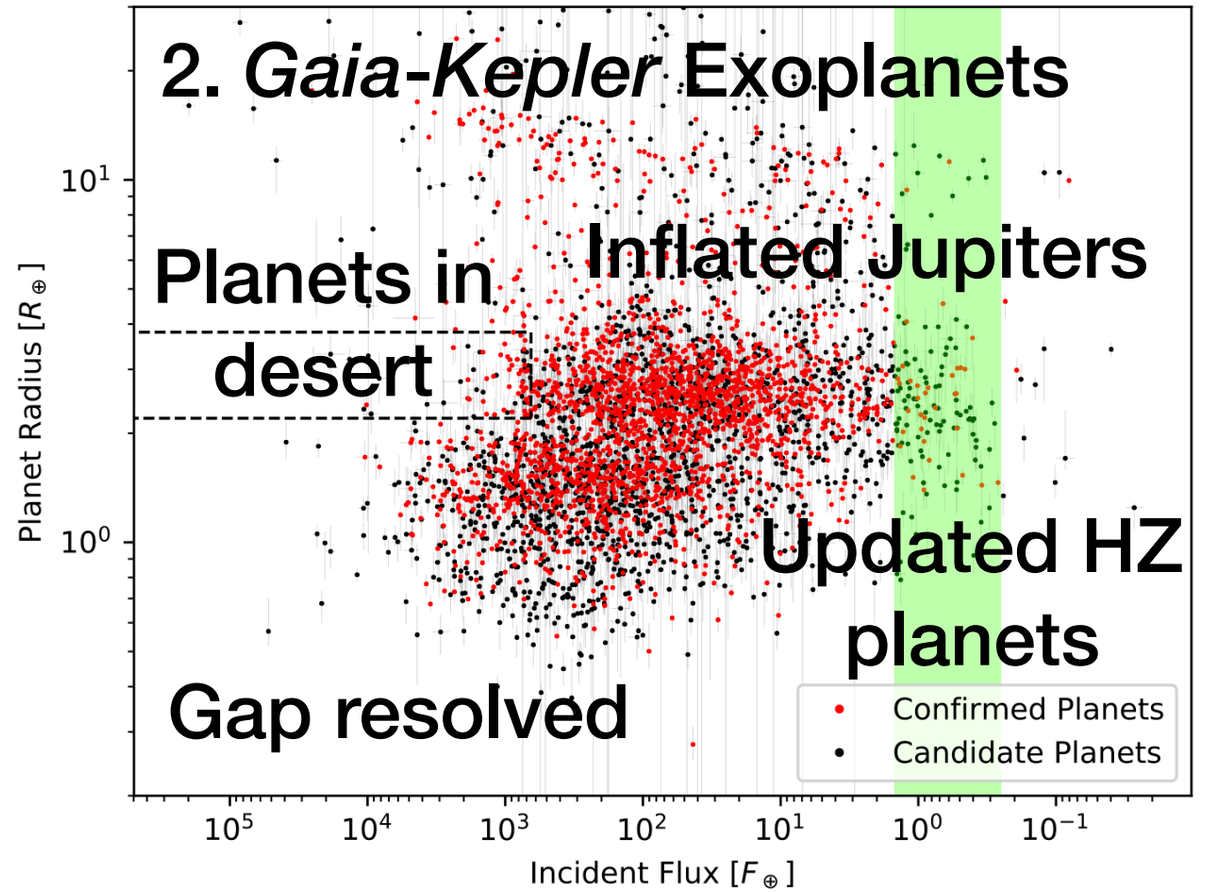
10^1
10^0

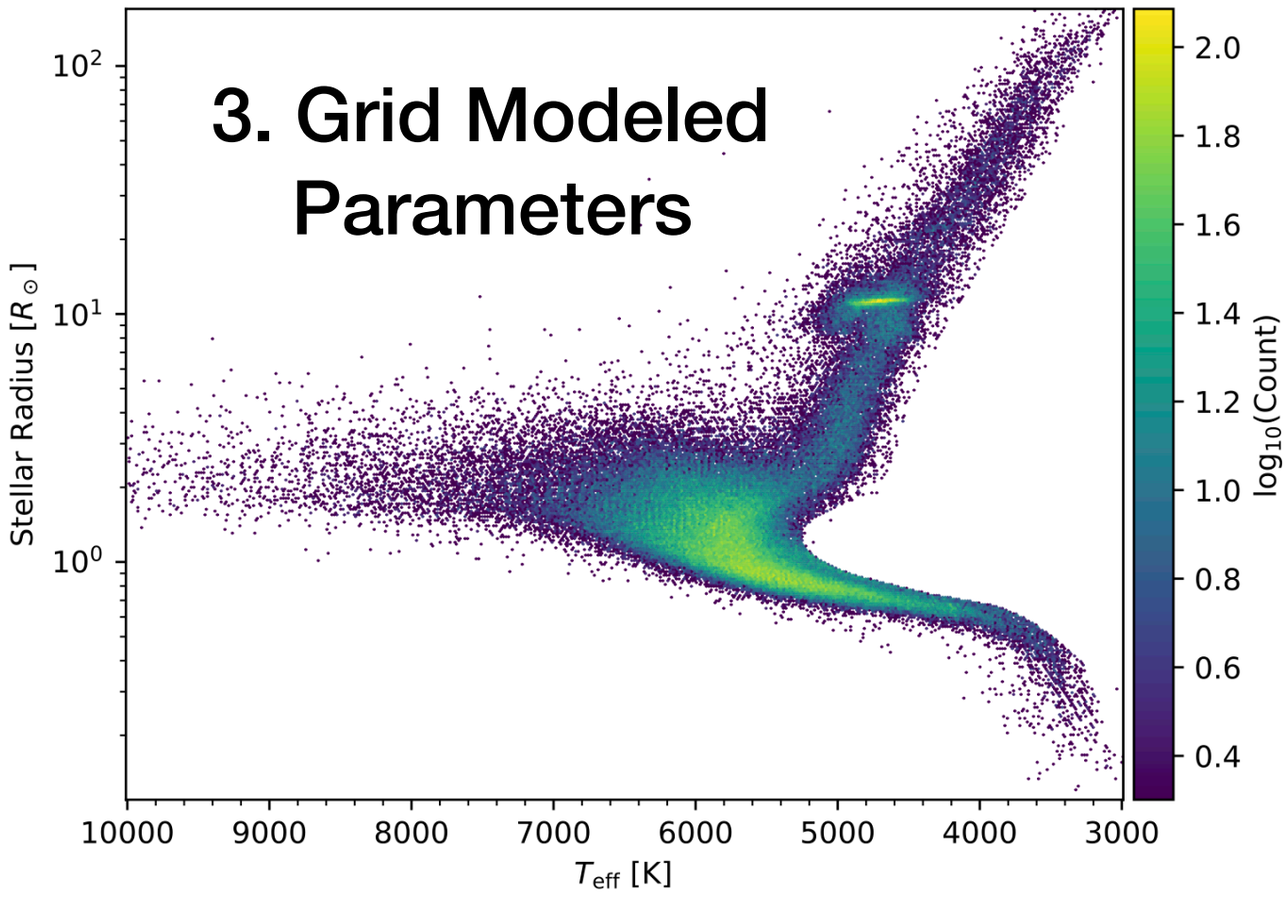
10^5 10^4 10^3 10^2 10^1 10^0 10^{-1}

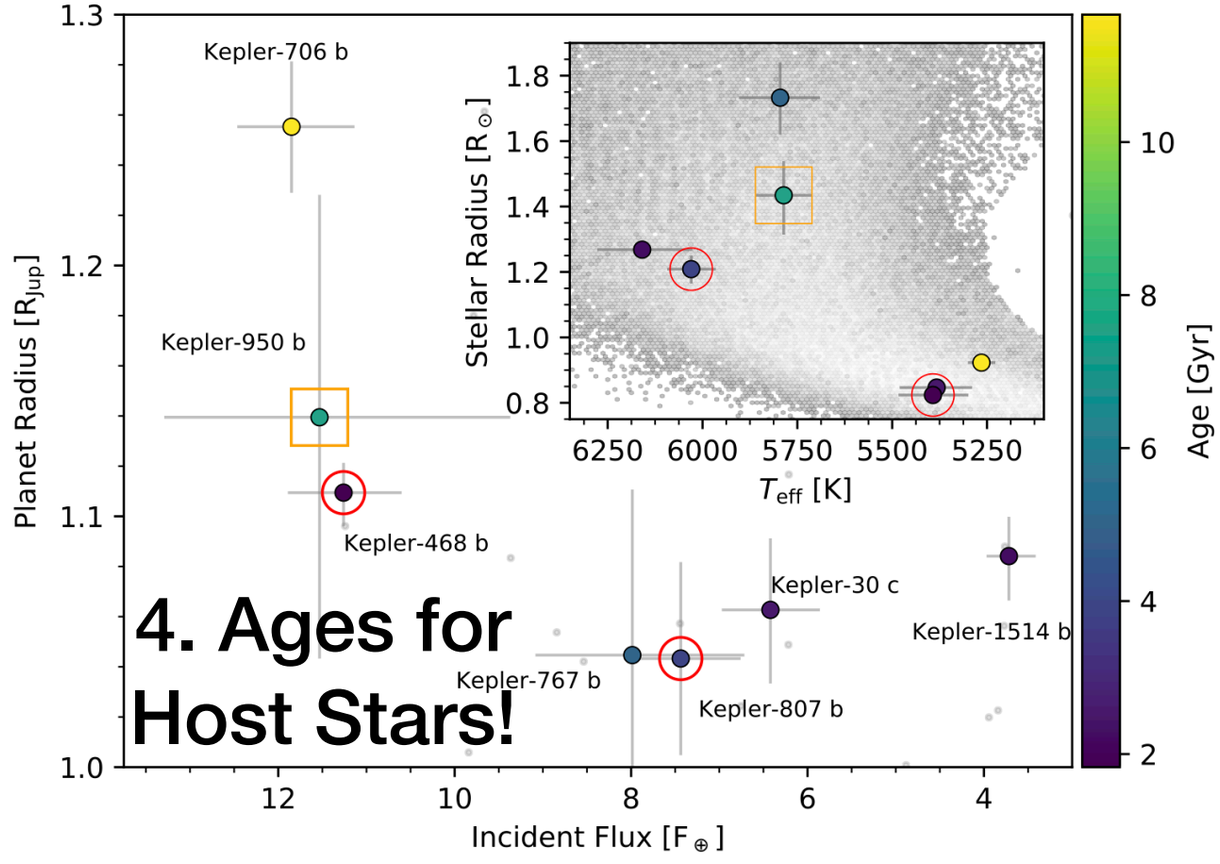
Incident Flux [$F_\oplus$]


Kepler-706 b
Kepler-950 b
Kepler-468 b
Kepler-767 b
Kepler-807 b
Kepler-30 c
Kepler-1514 b
Planet Radius [R_Jup]
Incident Flux [F_⊕]
Stellar Radius [R_⊙]
T_eff [K]
Age [Gyr]
1.3
1.2
1.1
1.0
12
10
8
6
4
1.8
1.6
1.4
1.2
1.0
0.8
6250
6000
5750
5500
5250
10
8
6
4
2


1. Gaia-Kepler H-R Diagram
21% Subgiant
12% RGB
67% MS
Stellar Radius [$R_\odot$]
$T_{\rm eff}$ [K]
log$_{10}$(Count)


2. Gaia-Kepler Exoplanets
Planets in desert
Inflated Jupiters
Updated HZ planets
Gap resolved
Confirmed Planets
Candidate Planets
Planet Radius [$R_\oplus$]
Incident Flux [$F_\oplus$]


3. Grid Modeled Parameters
Stellar Radius [$R_\odot$]
$T_{\rm eff}$ [K]
log$_{10}$(Count)


4. Ages for Host Stars!
Kepler-706 b
Kepler-950 b
Kepler-468 b
Kepler-30 c
Kepler-1514 b
Kepler-767 b
Kepler-807 b
Stellar Radius [$R_\odot$]
$T_{\rm eff}$ [K]
Planet Radius [$R_{\rm Jup}$]
Incident Flux [$F_\oplus$]
Age [Gyr]