Revealing the Demographics of Exoplanets in Binary Star Systems

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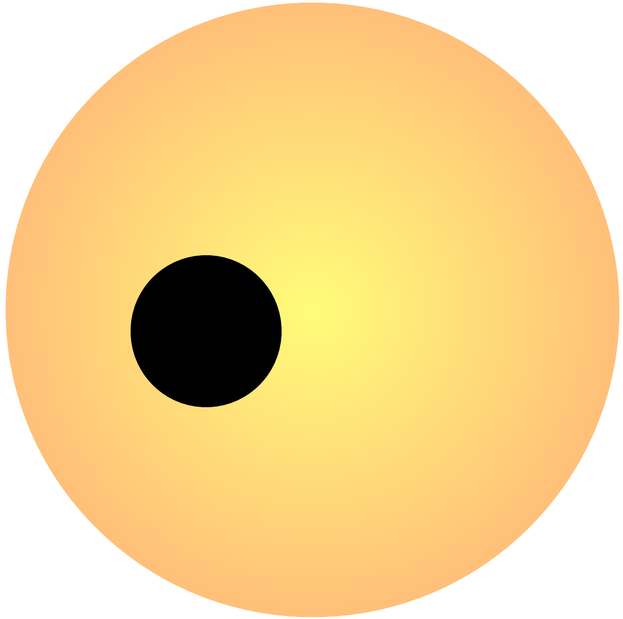
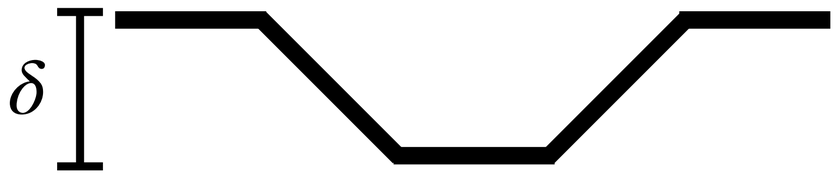
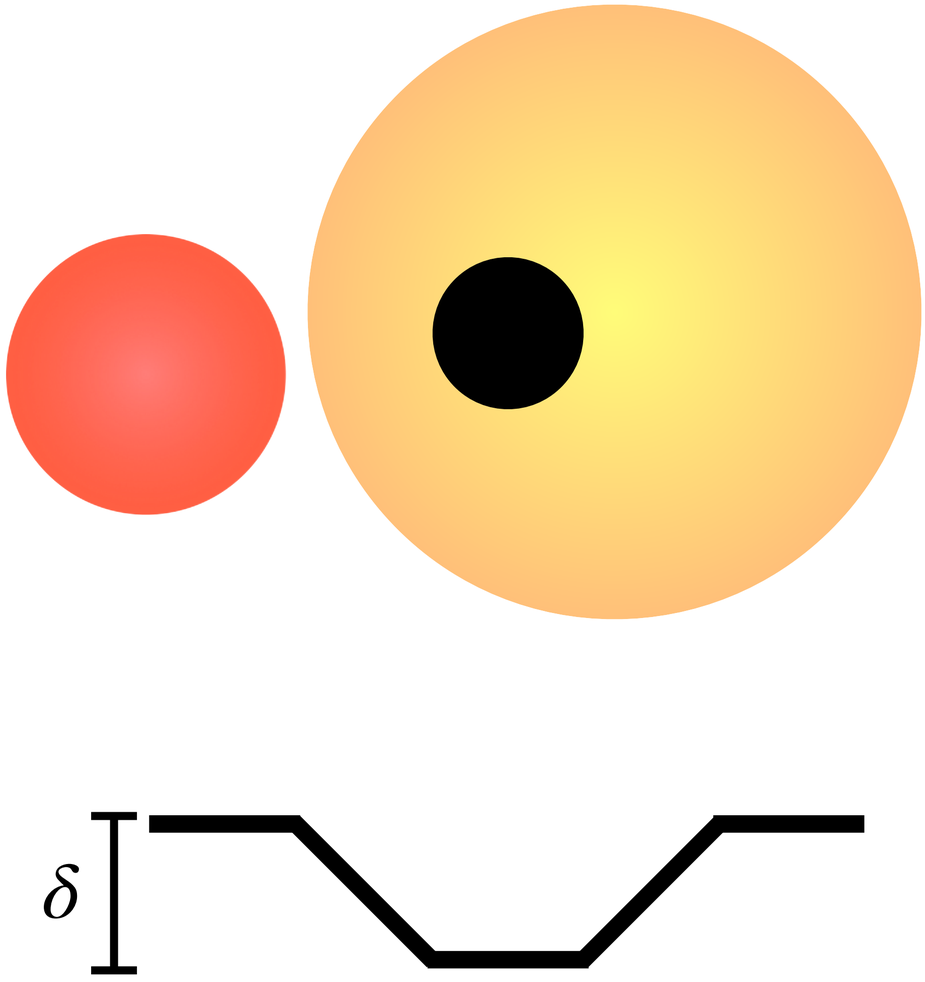
Biases introduced by stellar multiplicity limit our ability to explore exoplanet demographics

Stellar multiplicity impacts transits





Stellar multiplicity impacts transits



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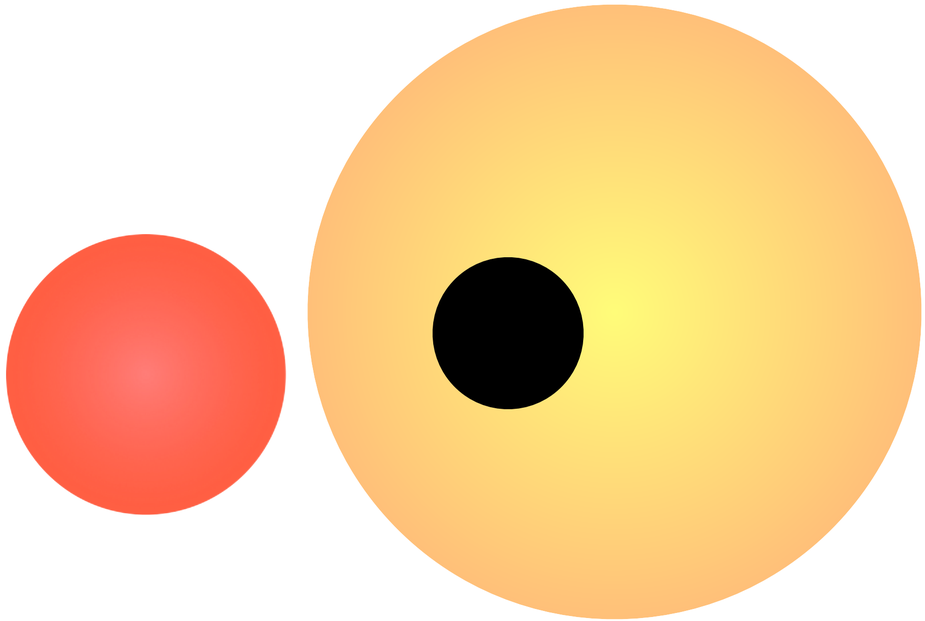
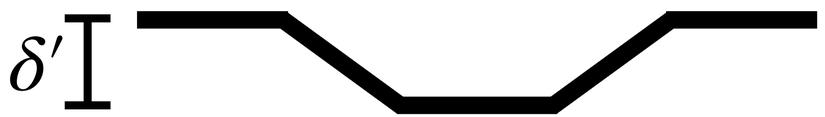
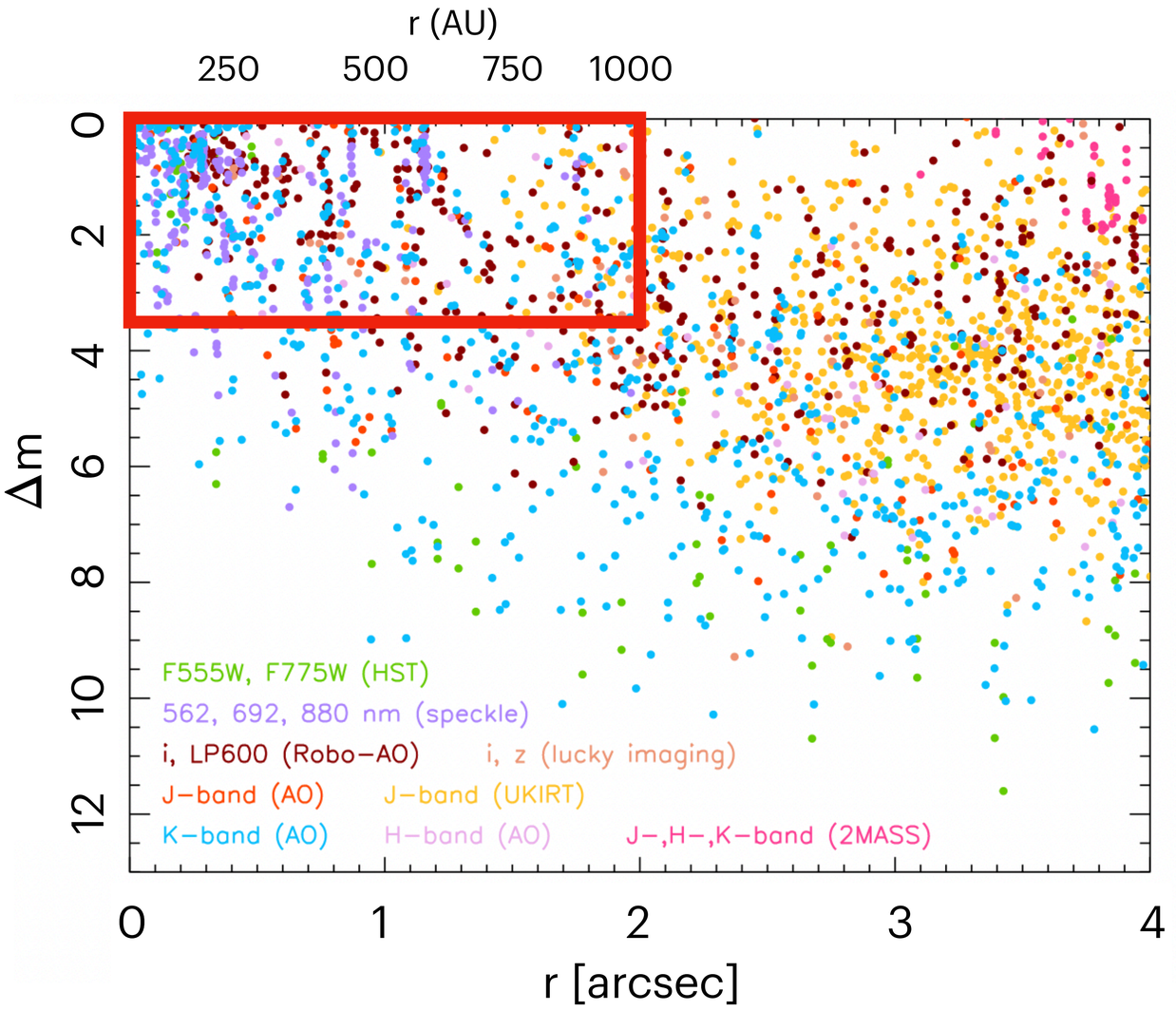




The HET-Kepler Survey

An ongoing moderate-resolution red-optical spectroscopic survey of Kepler binary star planet hosts using the Hobby-Eberly Telescope (HET) at McDonald Observatory in West Texas

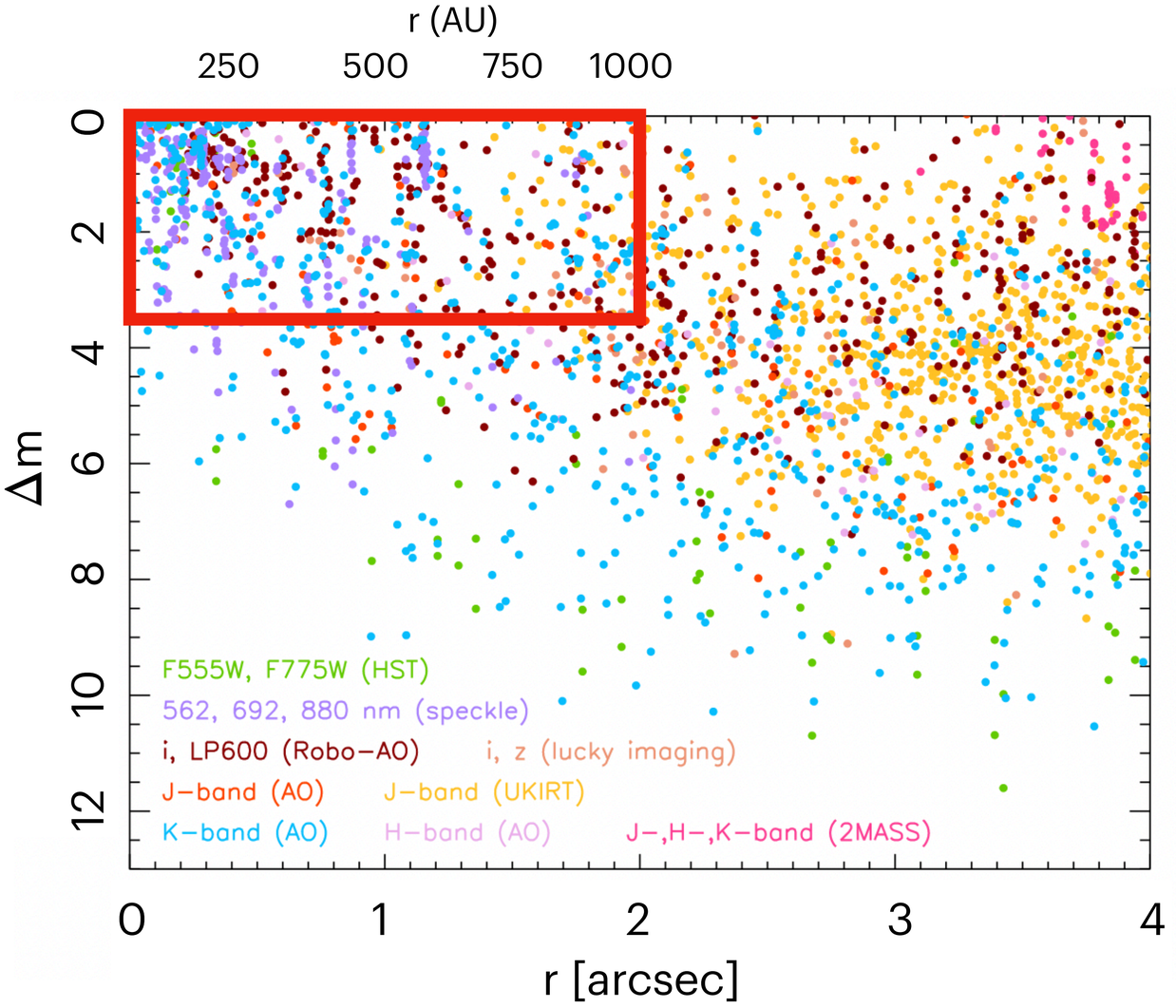


Furlan et al. 2017

The HET-Kepler Survey

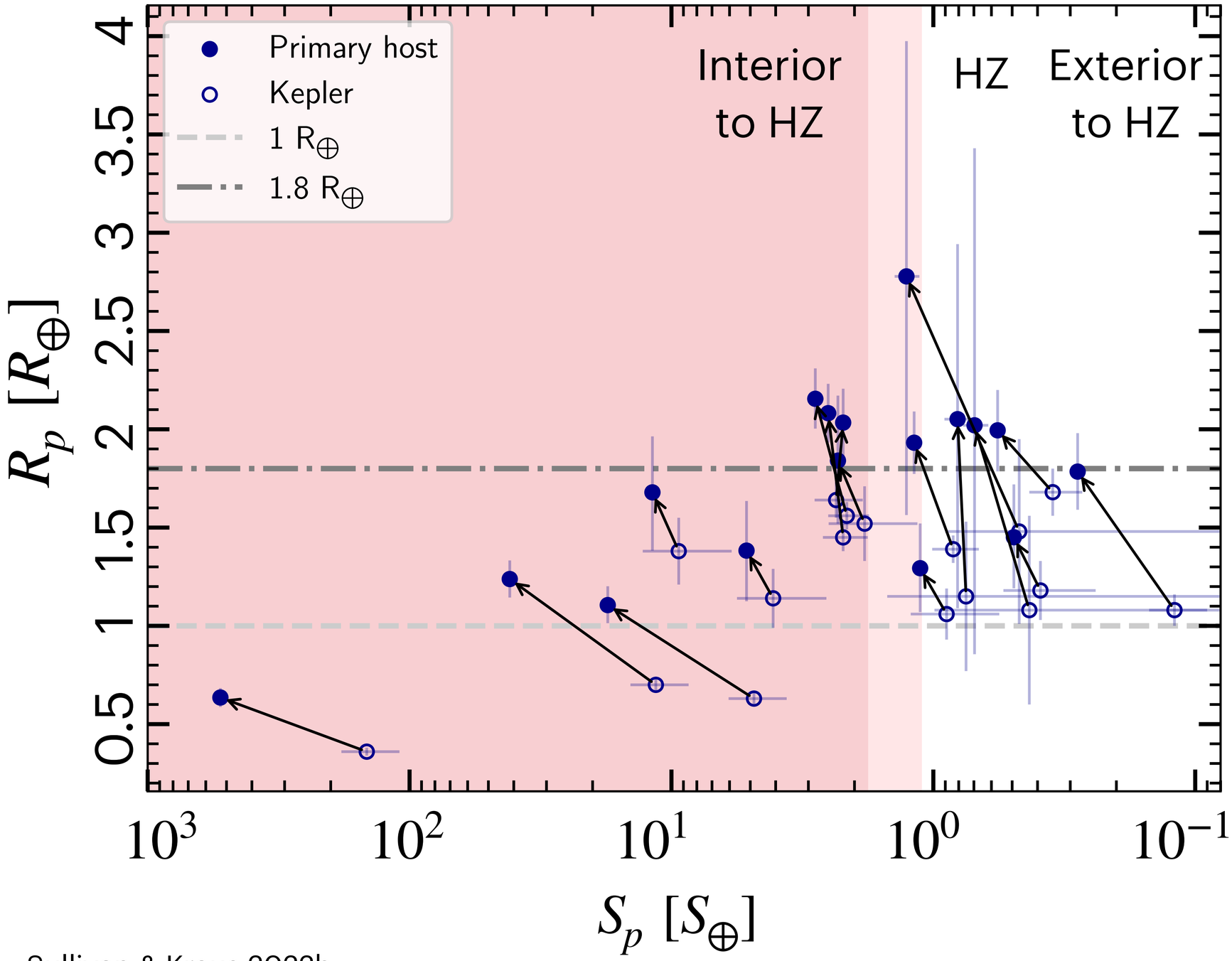
An ongoing moderate-resolution red-optical spectroscopic survey of Kepler binary star planet hosts using the Hobby-Eberly Telescope (HET) at McDonald Observatory in West Texas

Working to survey <u>previously identified binaries</u> (mostly from Furlan et al. 2017) with separations $\rho < 2''$ and at least one contrast $\Delta m_{[\lambda]} < 3.5$ mag



Furlan et al. 2017

What is the impact of binaries on single-star planet demographics?

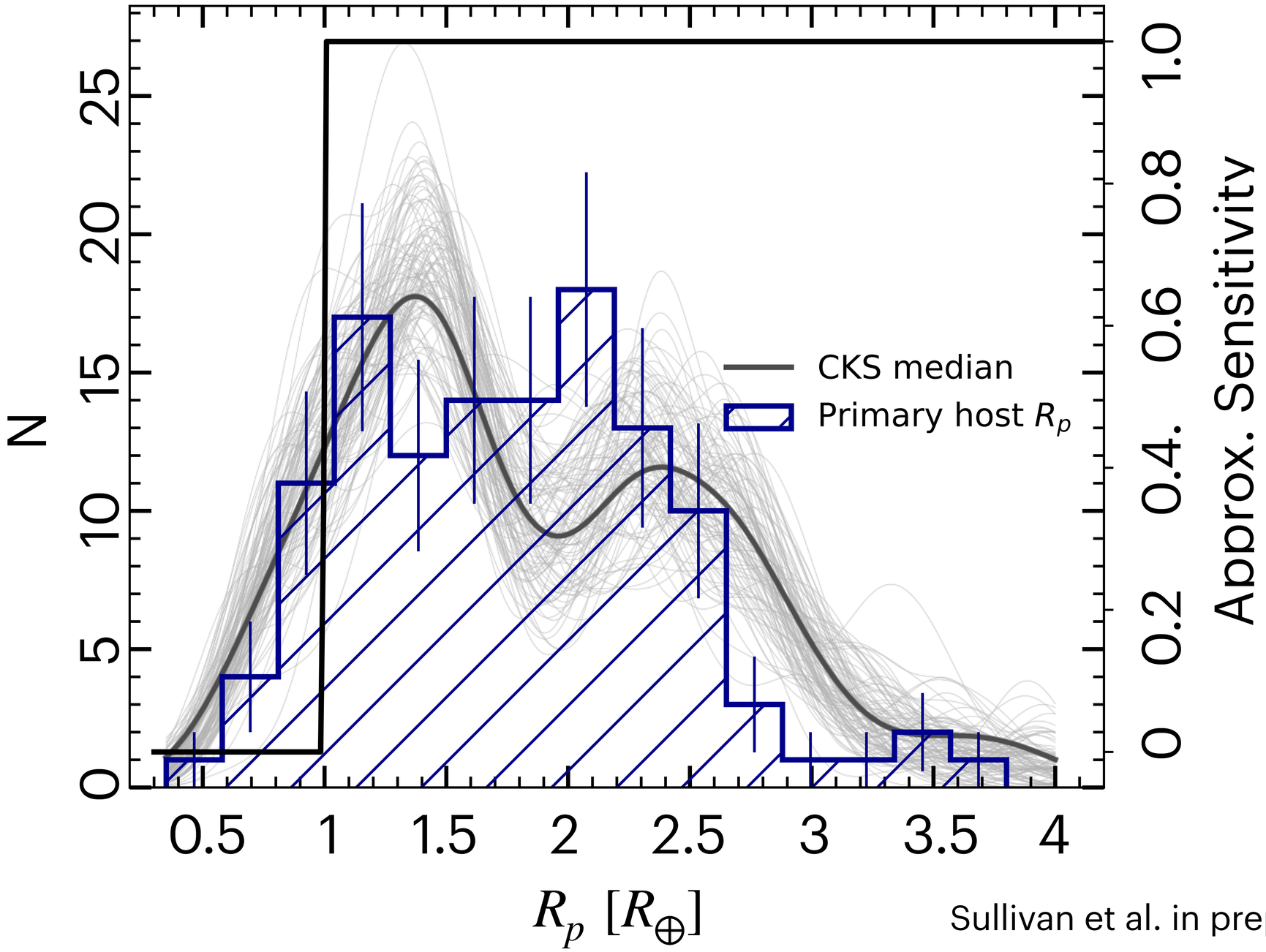


Corrected multiplicity shifts planets to larger radii and moves systems in/out of the HZ

Sullivan & Kraus 2022b

Do planets in binaries have different demographics than those in single stars?

The binary star planet radius distribution is inconsistent with single star observations



Sullivan et al. in prep

Conclusions

- Stellar multiplicity can significantly change observed planet properties in transiting systems

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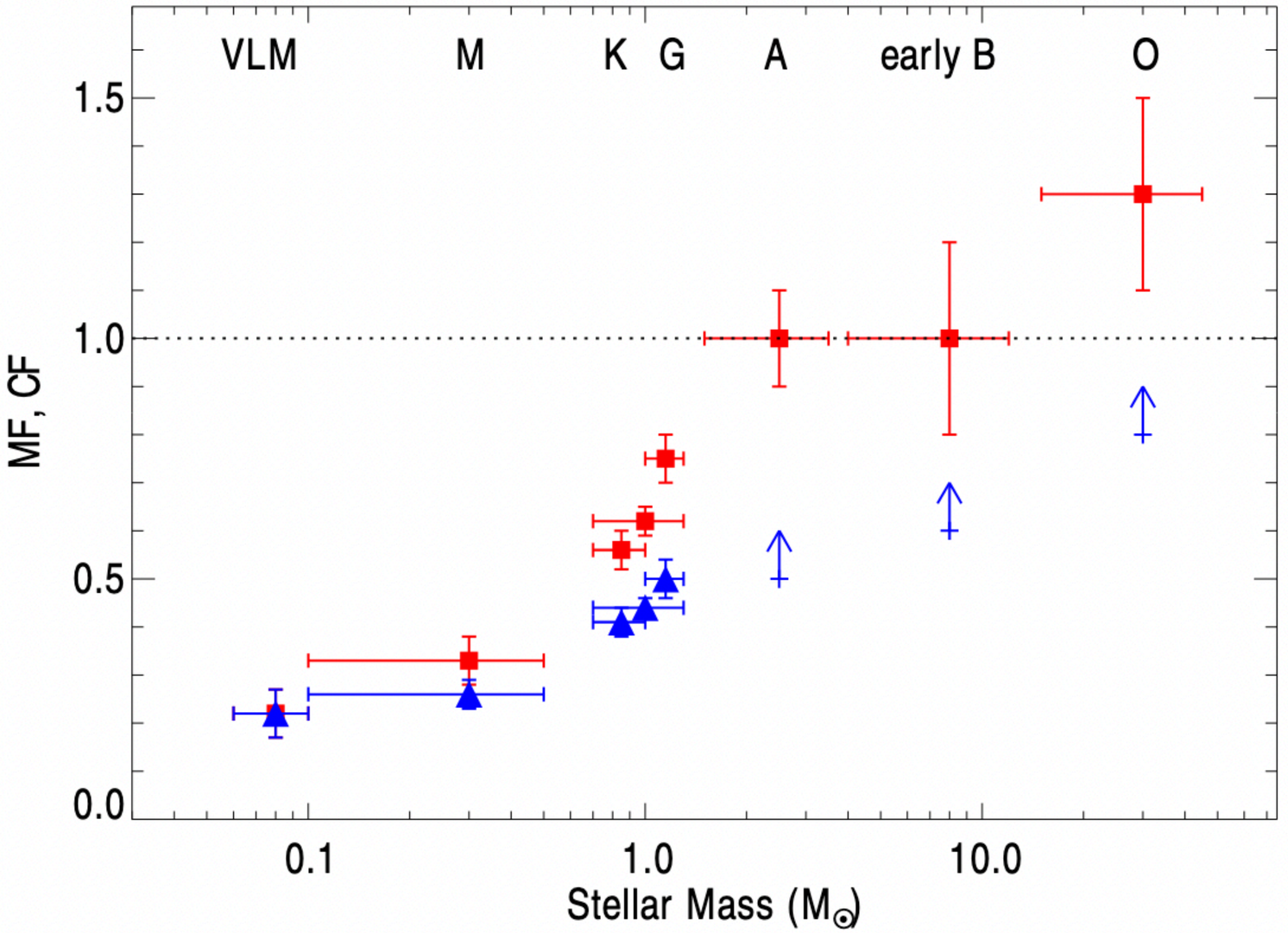
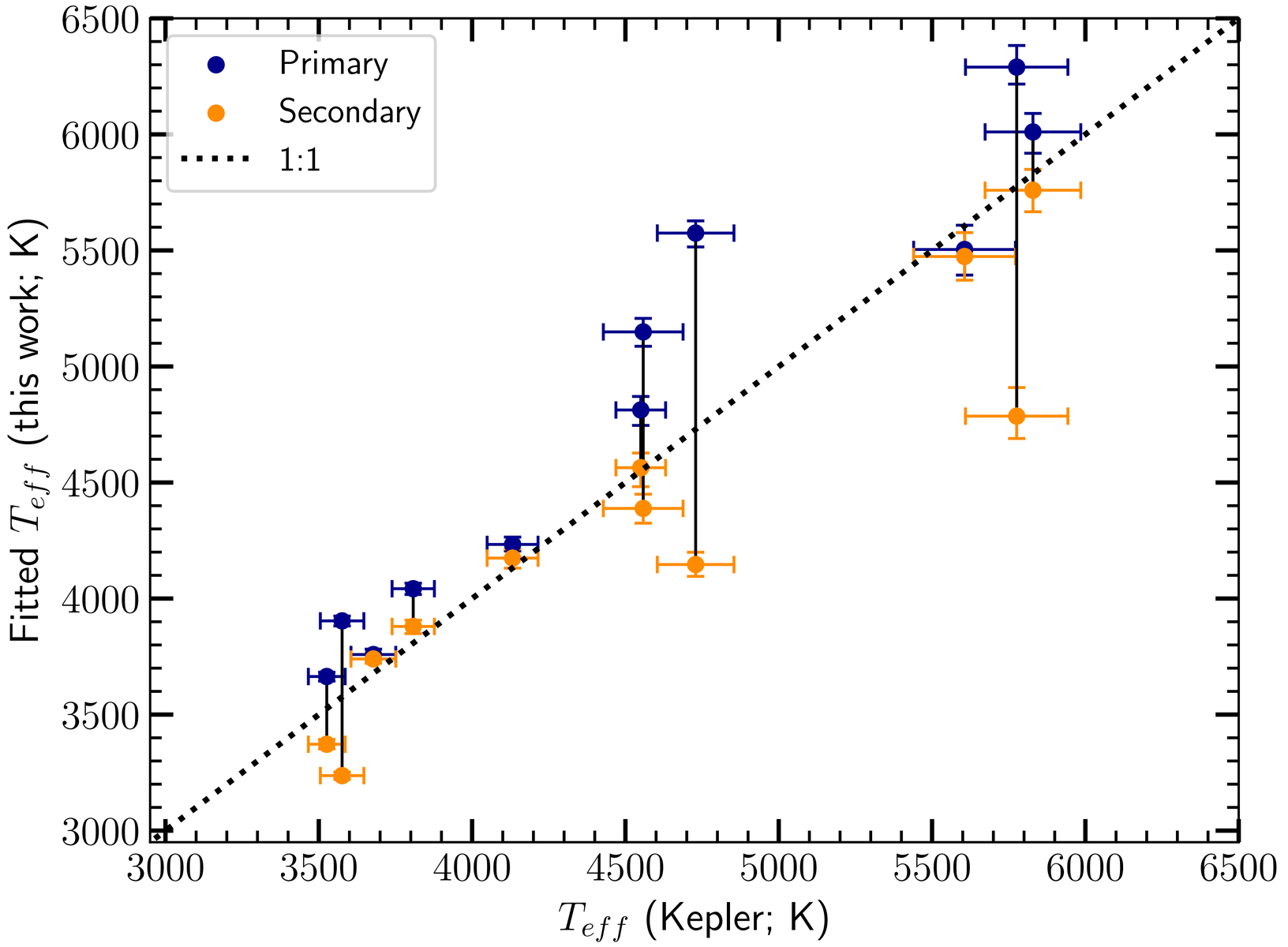
- Corrected multiplicity shifts planets to larger radii and changes which systems are in the HZ, with implications for $\eta_{\oplus}$
- Revision of planet properties reveals differences between planet populations in binary and single stars
  - The binary star planet radius distribution is inconsistent with single-star observations

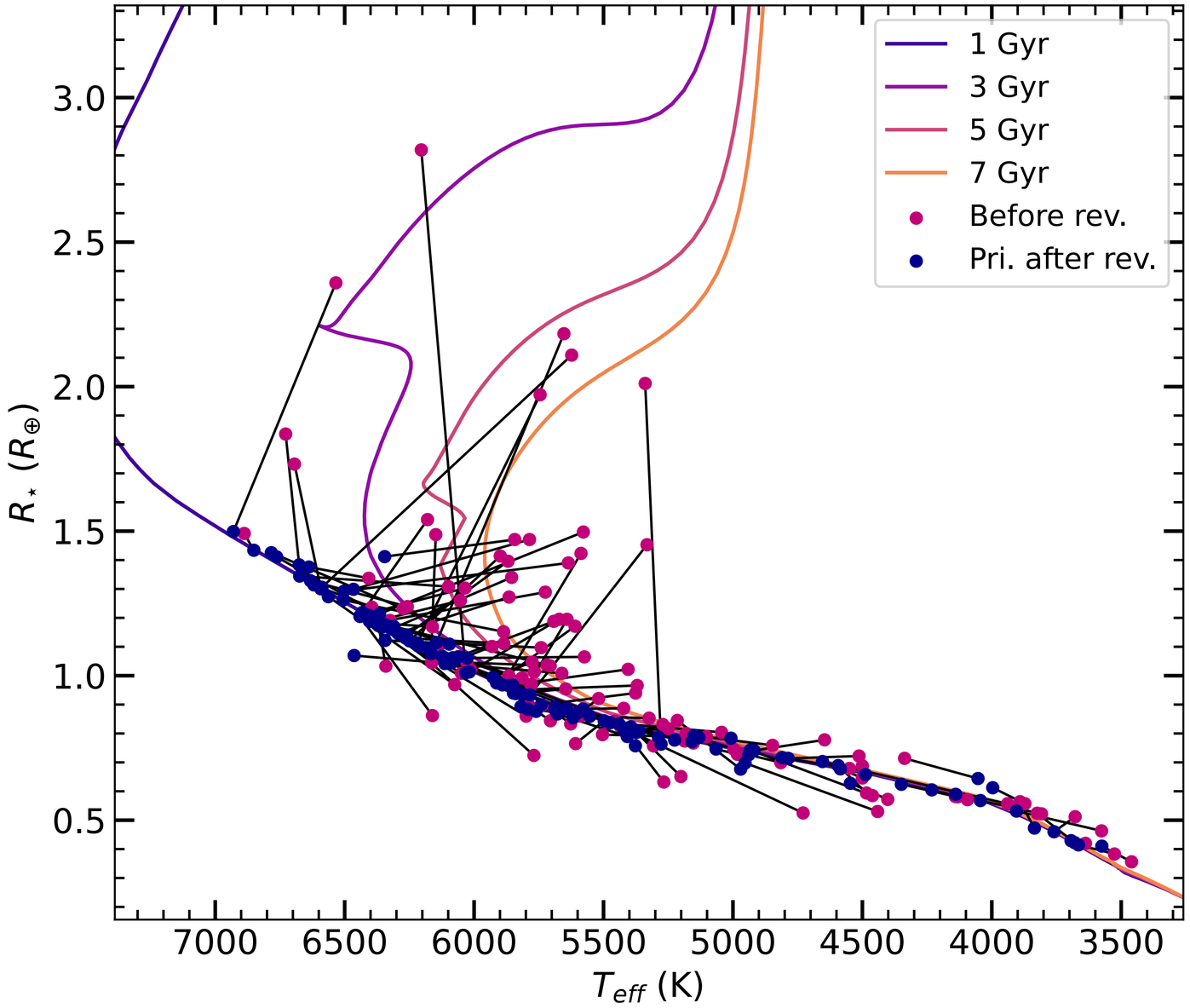
Backup

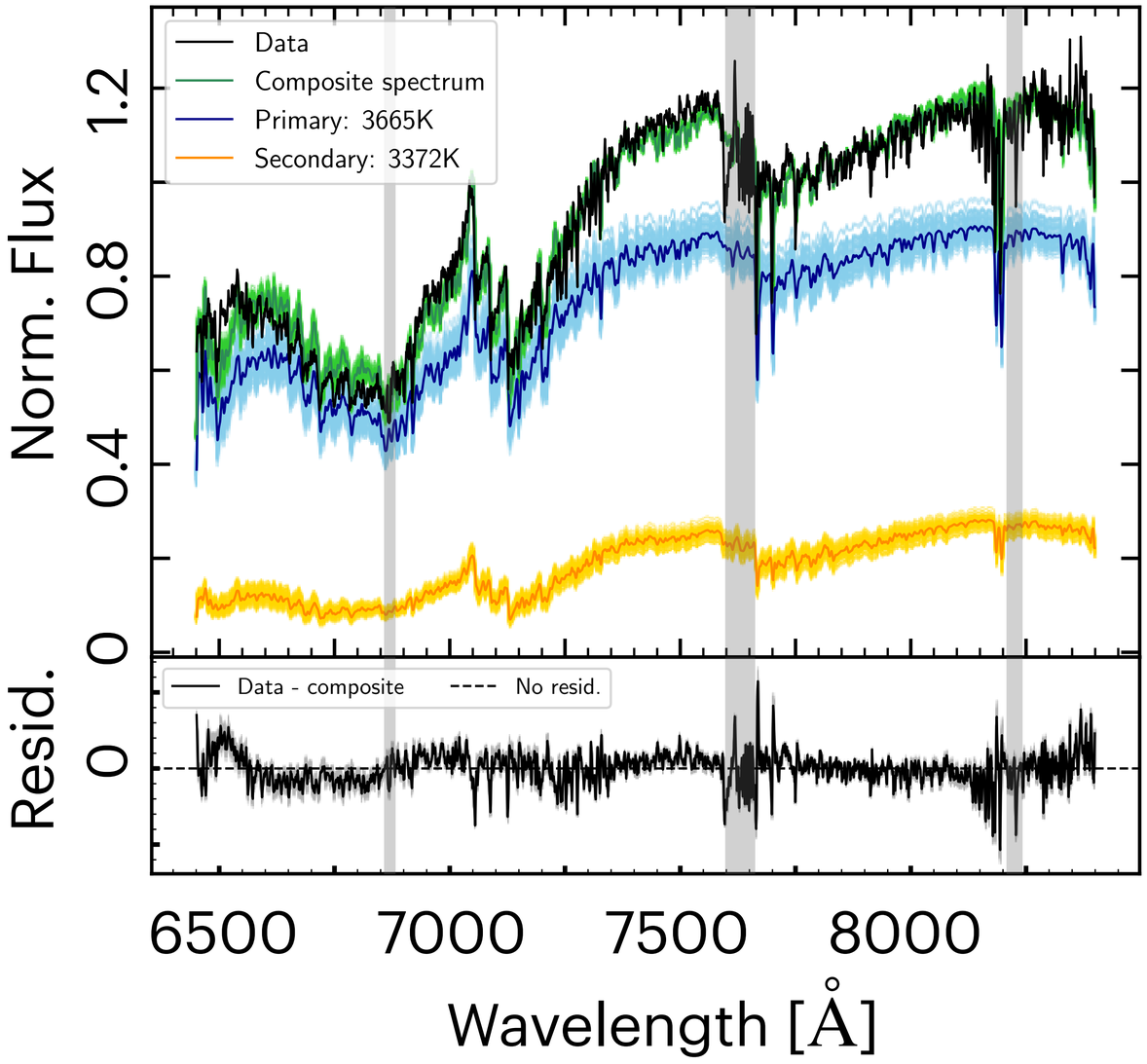
Stellar multiplicity is ubiquitous

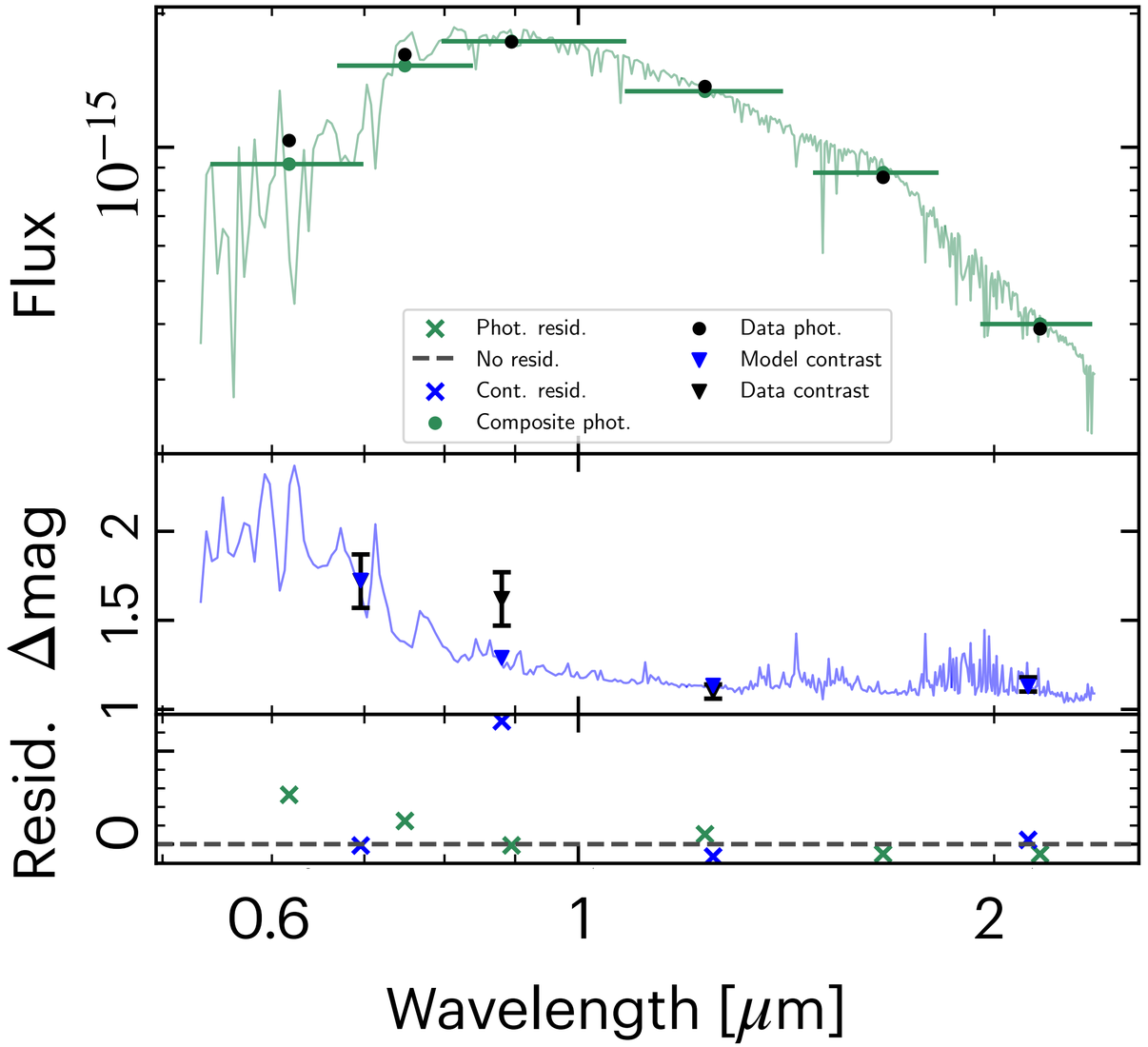


Duchêne and Kraus 2013

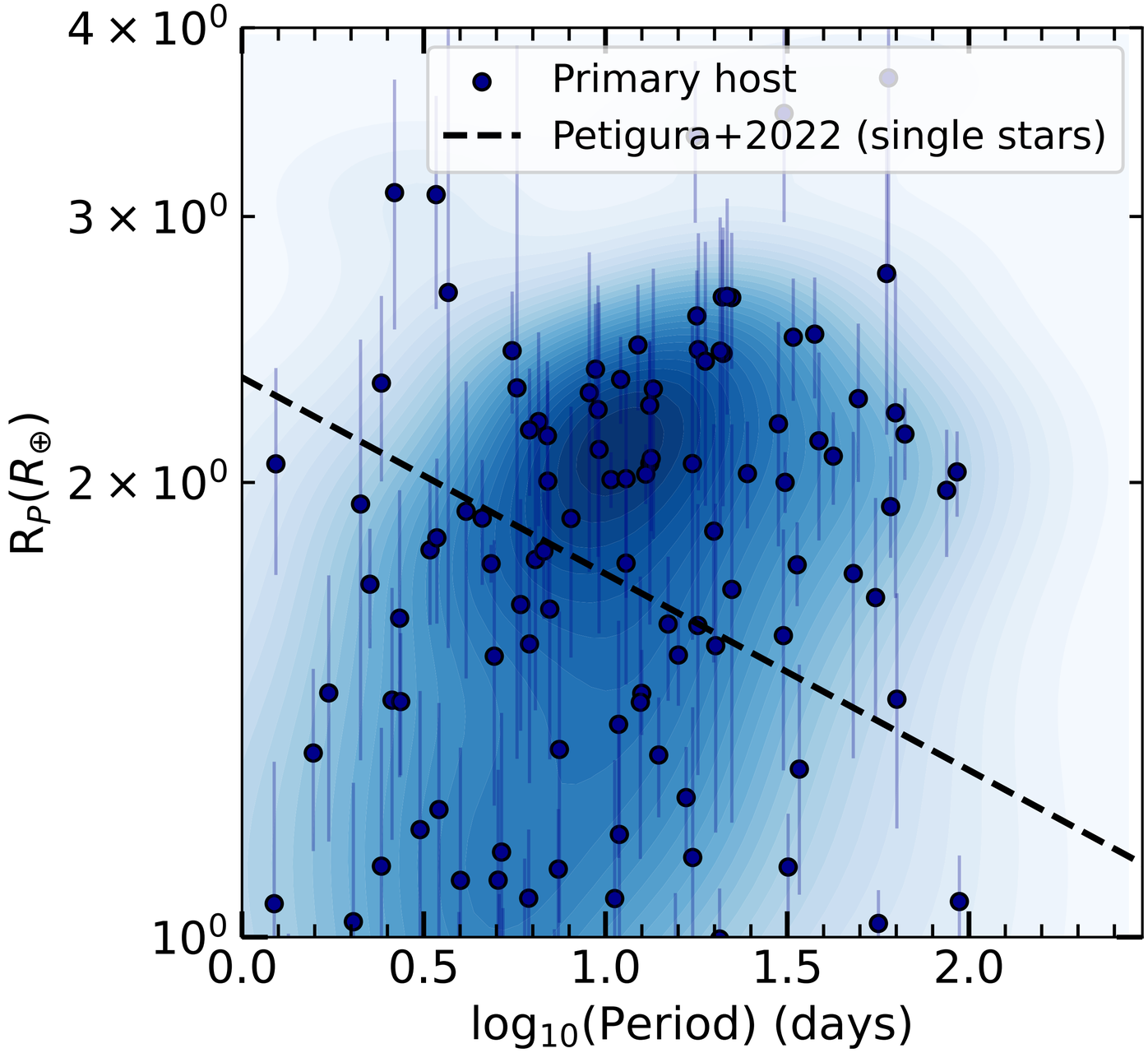

Primary
Secondary
1:1
Fitted T_{eff} (this work; K)
T_{eff} (Kepler; K)
3000
3500
4000
4500
5000
5500
6000
6500


1 Gyr
3 Gyr
5 Gyr
7 Gyr
Before rev.
Pri. after rev.
3.0
2.5
2.0
1.5
1.0
0.5
$R_\star$ ($R_\oplus$)
7000
6500
6000
5500
5000
4500
4000
3500
T_{eff} (K)

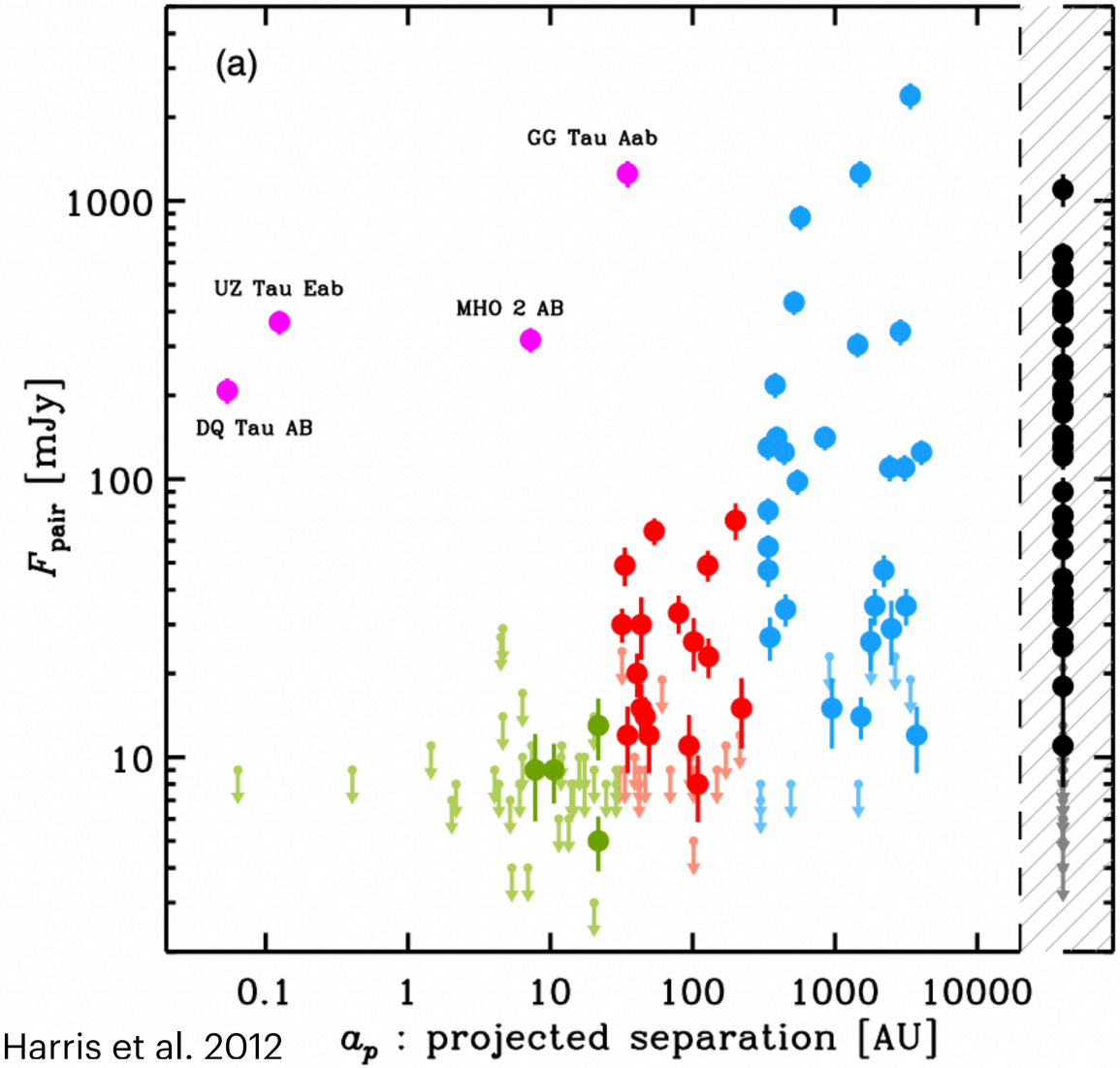




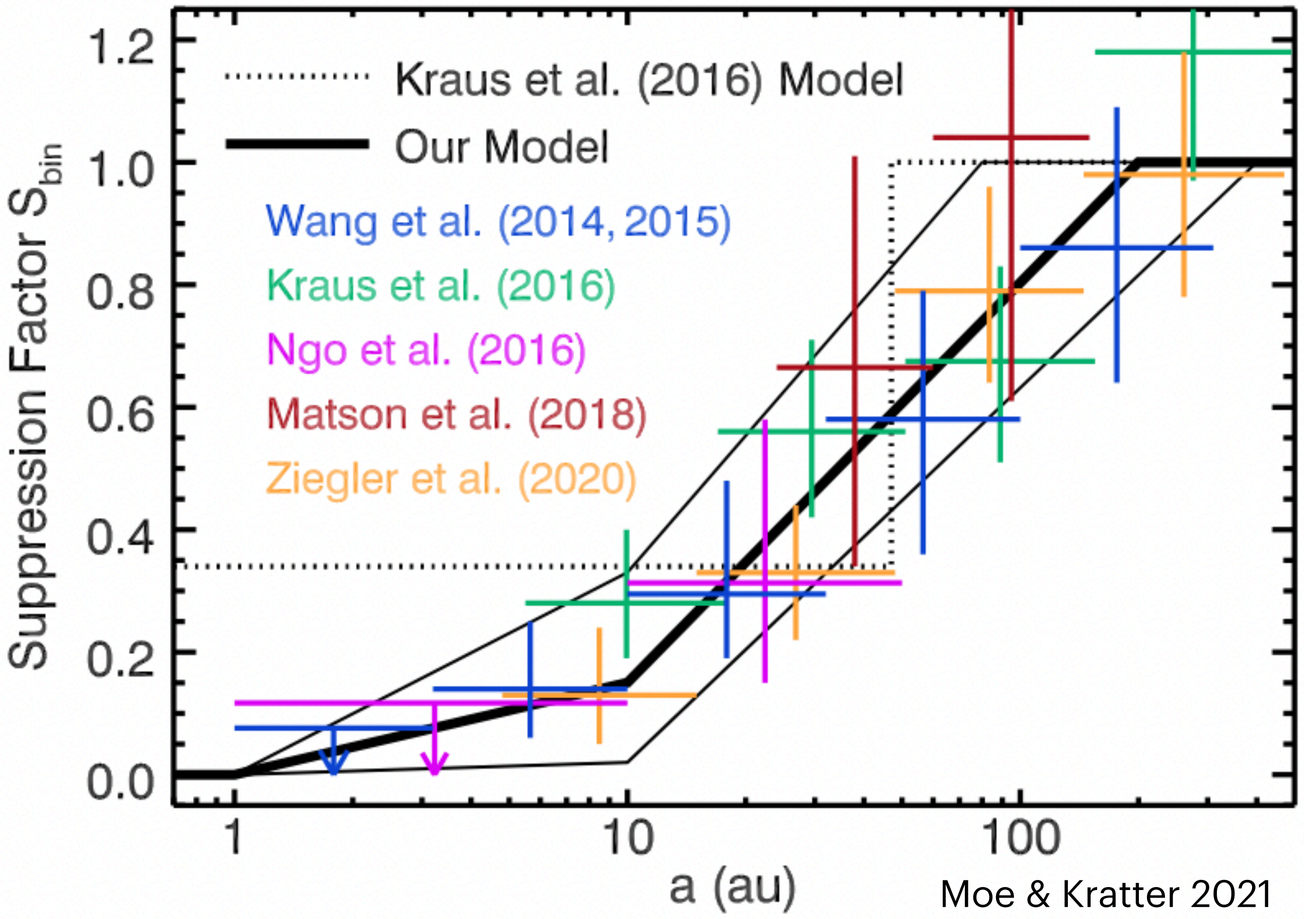
KOI-1422; Sullivan et al. 2022


Primary host
Petigura+2022 (single stars)
4×10^0
3×10^0
2×10^0
10^0
$R_P(R_\oplus)$
0.0
0.5
1.0
1.5
2.0
$\log_{10}$(Period) (days)

Binaries impact planet formation and survival



Harris et al. 2012



Moe & Kratter 2021

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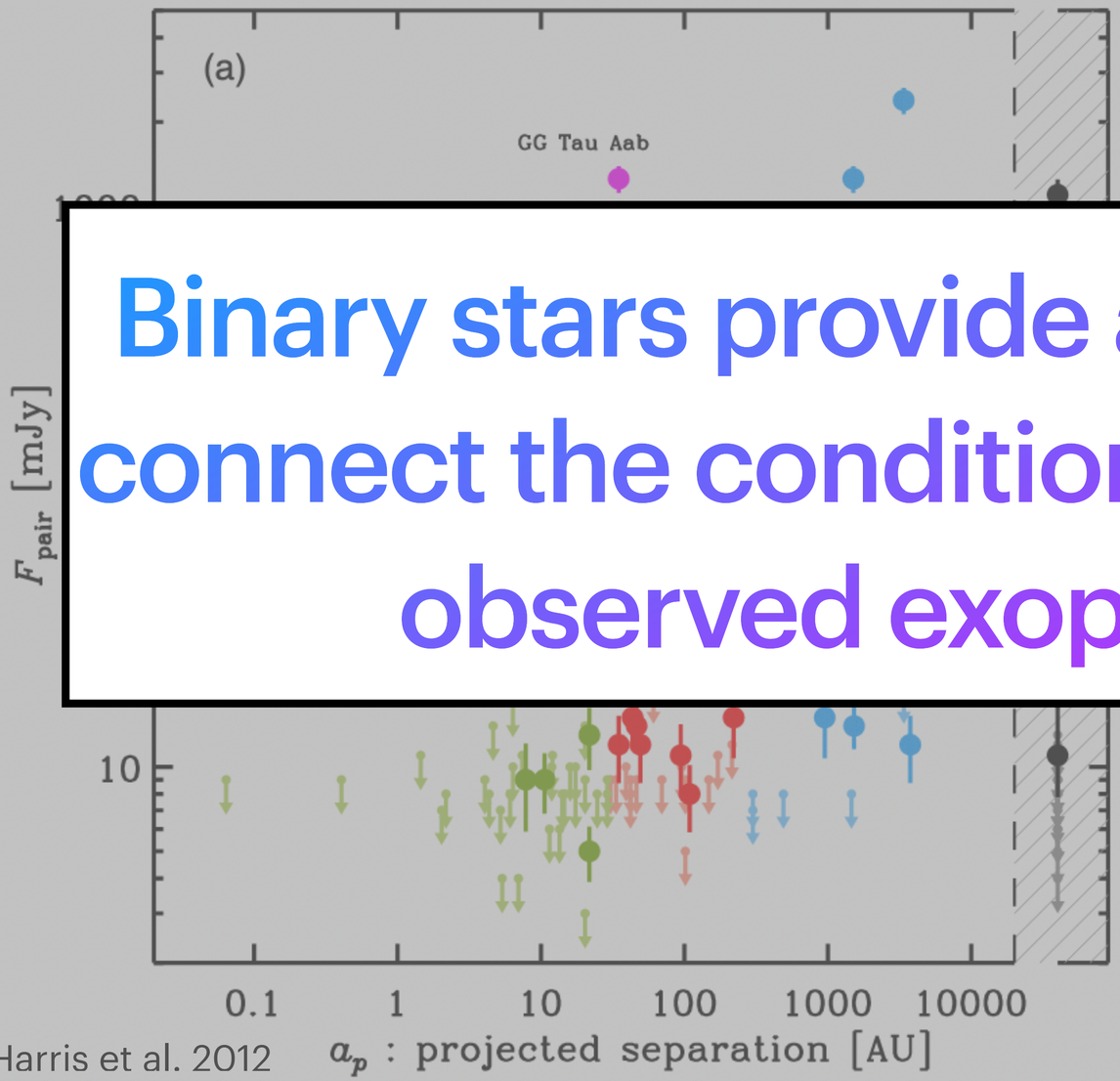
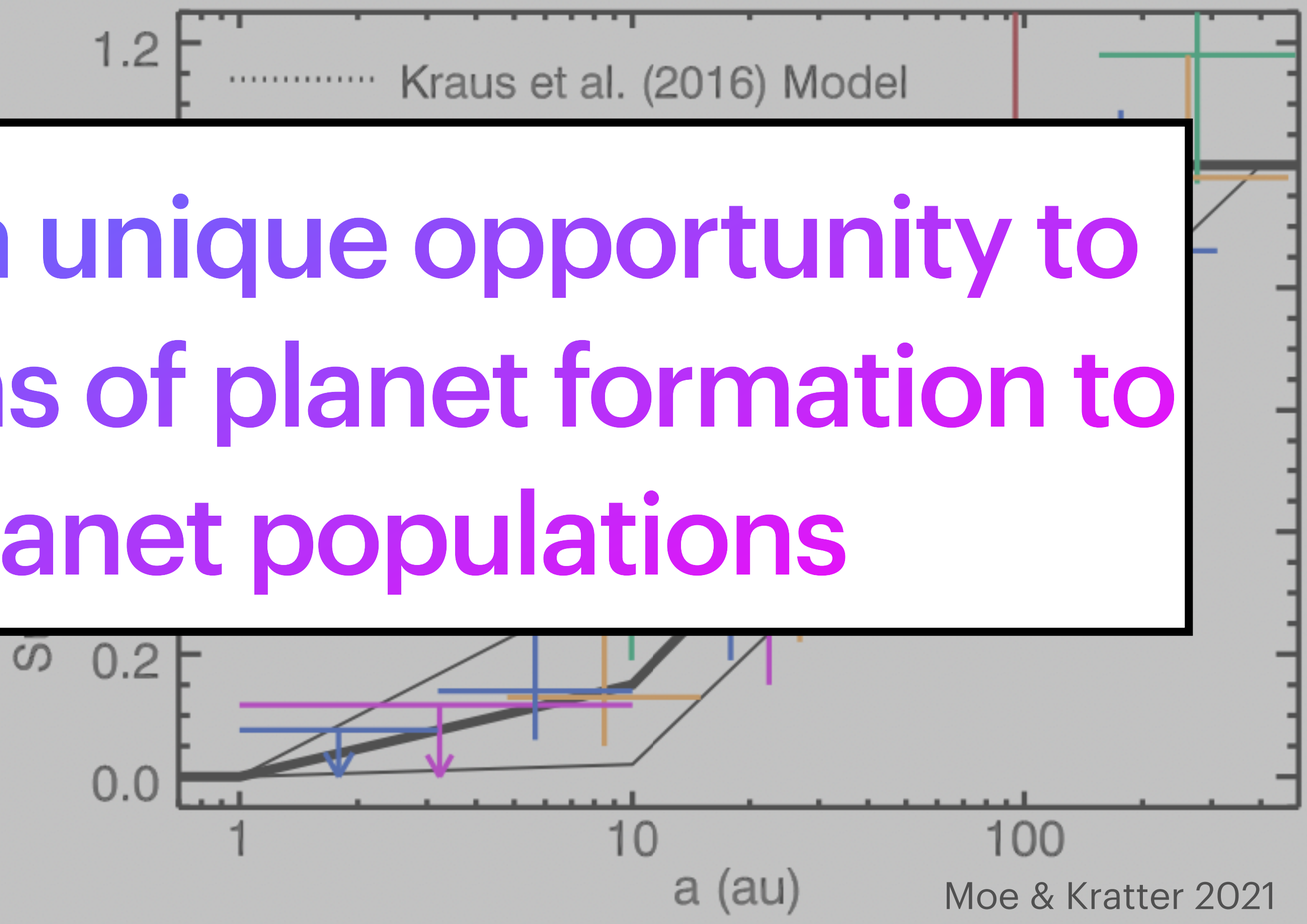


Harris et al. 2012



Moe & Kratter 2021

Binary stars provide a unique opportunity to connect the conditions of planet formation to observed exoplanet populations