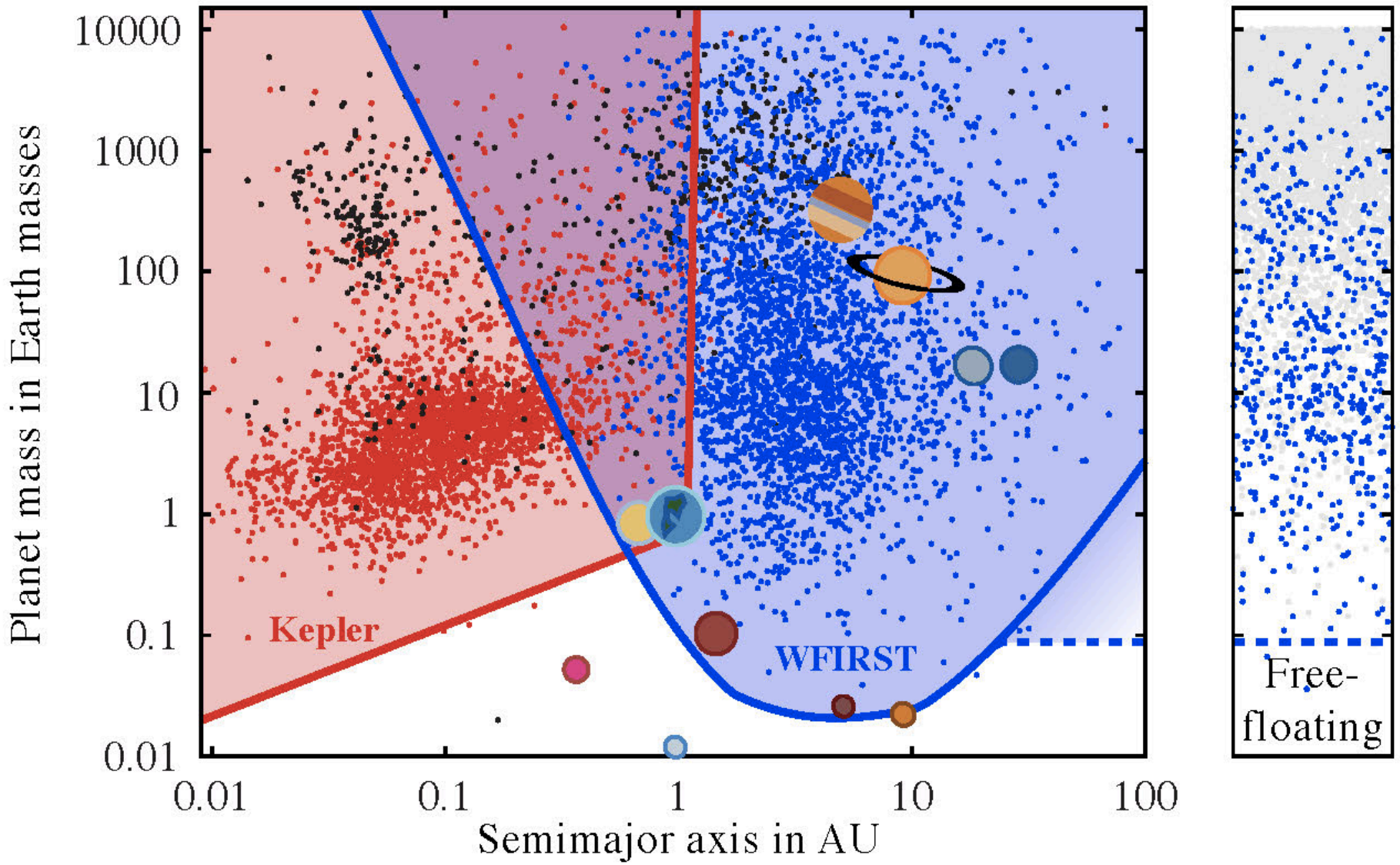
Harvard-Smithsonian
Center for Astrophysics

Microlensing Surveys for Planets with WFIRST

Jennifer C. Yee



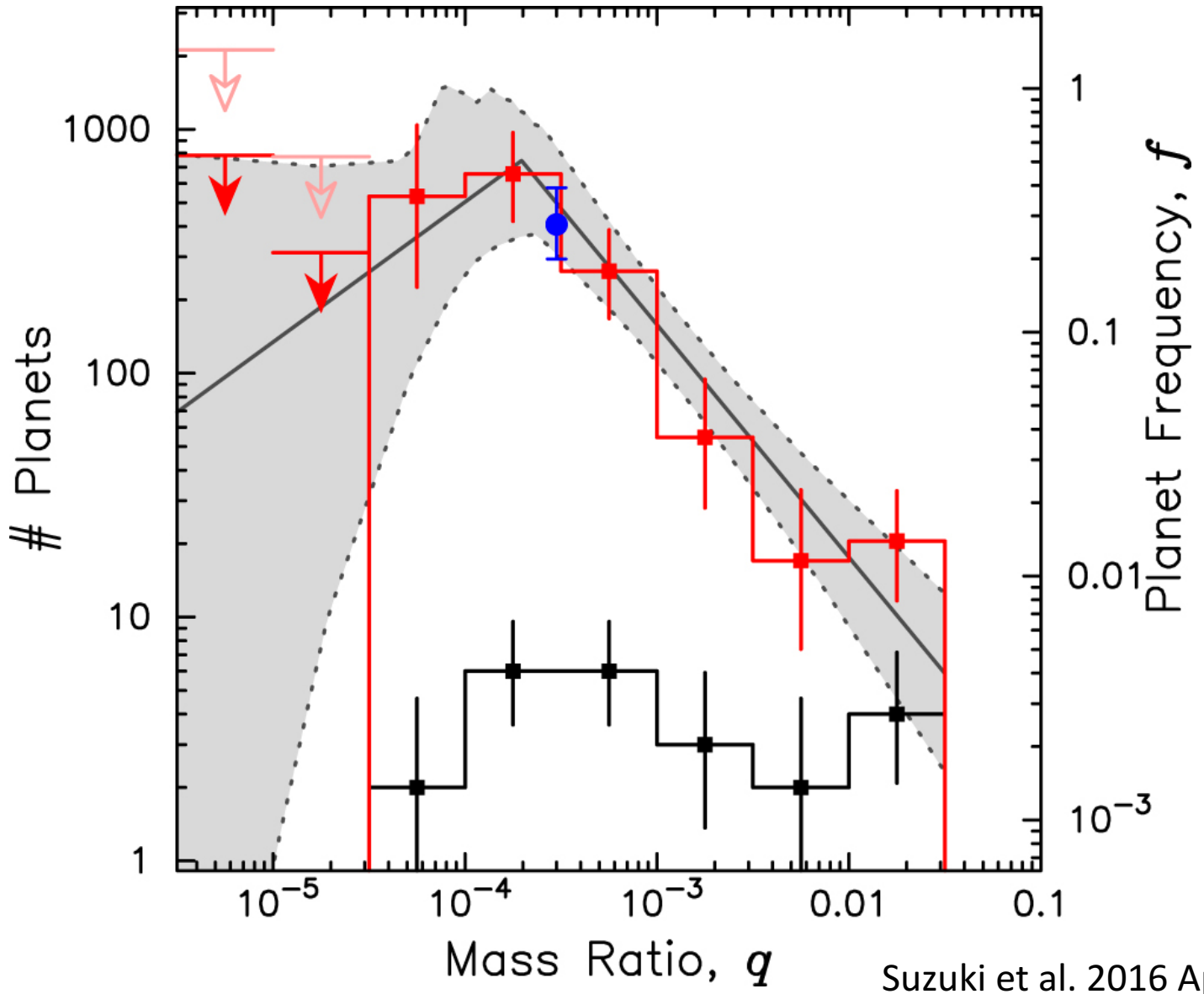
Plot by Matthew Penny

Planet Formation Physics from WFIRST Planets

- Snow Line Physics
- Planet Embryos & Planet Ejection
- Galactic Distribution of Planets

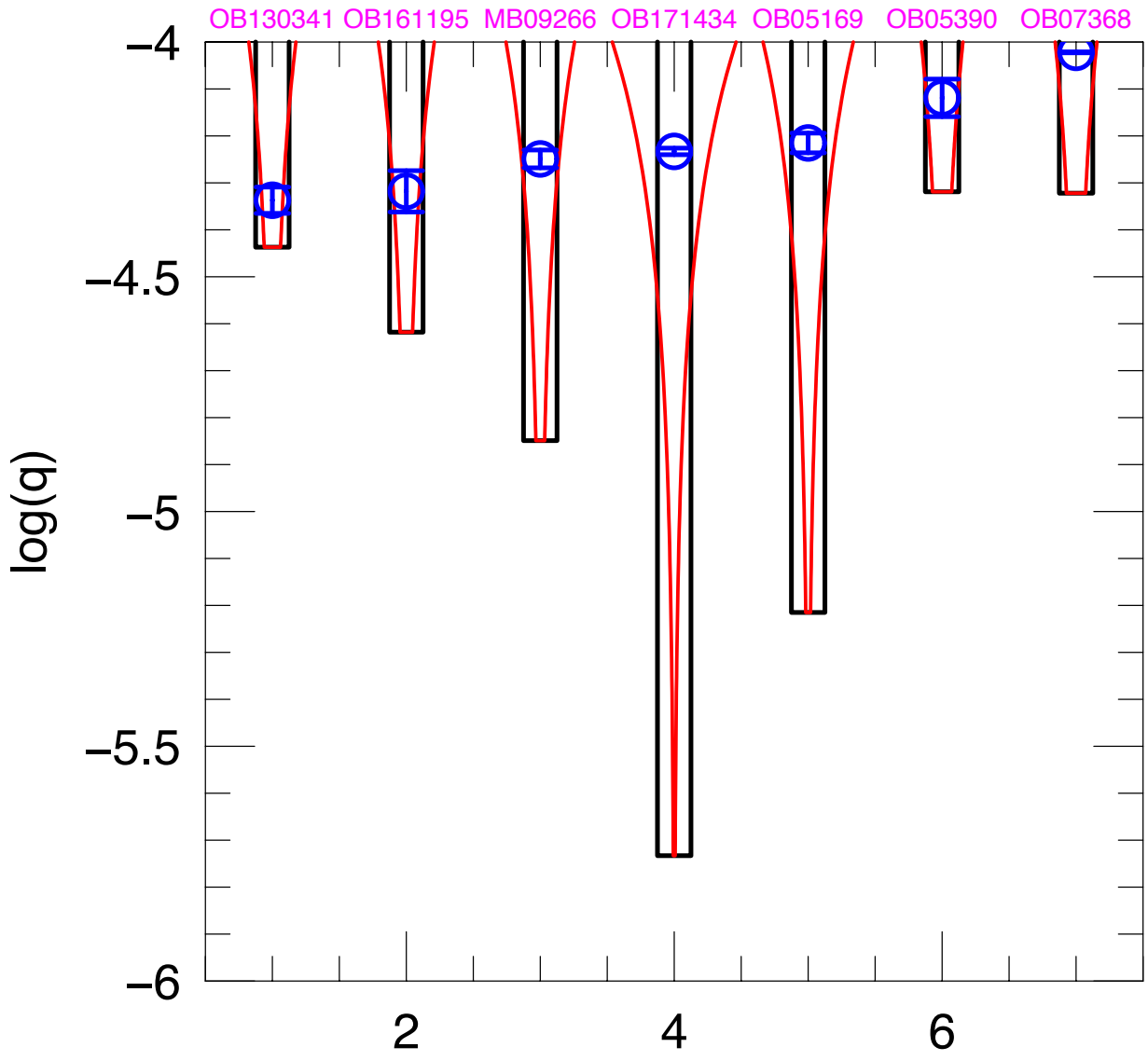
The Physics of the Snow Line

A break in the mass ratio function



Suzuki et al. 2016 ApJ 833, 145

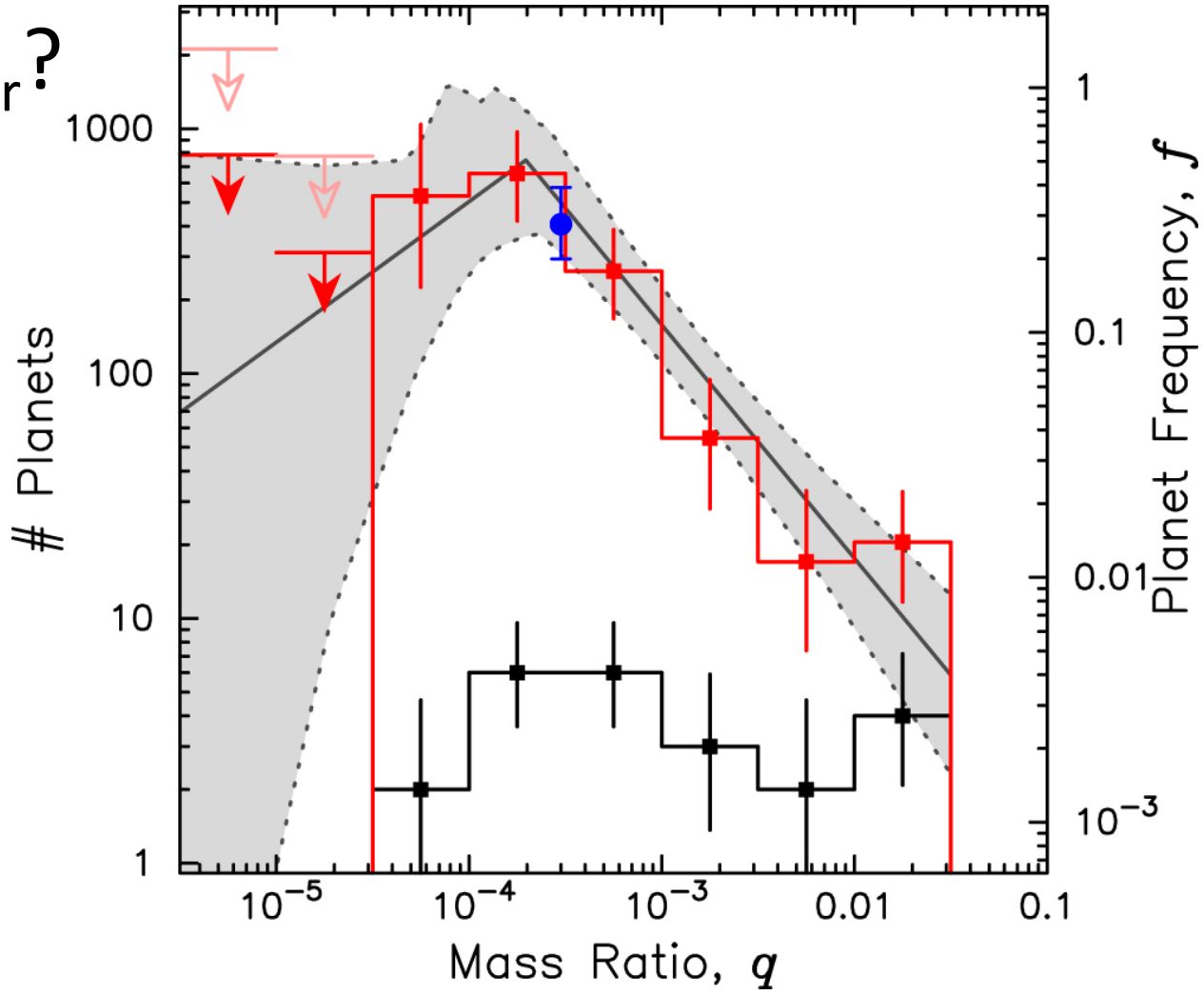
No planets with log q < -4.5



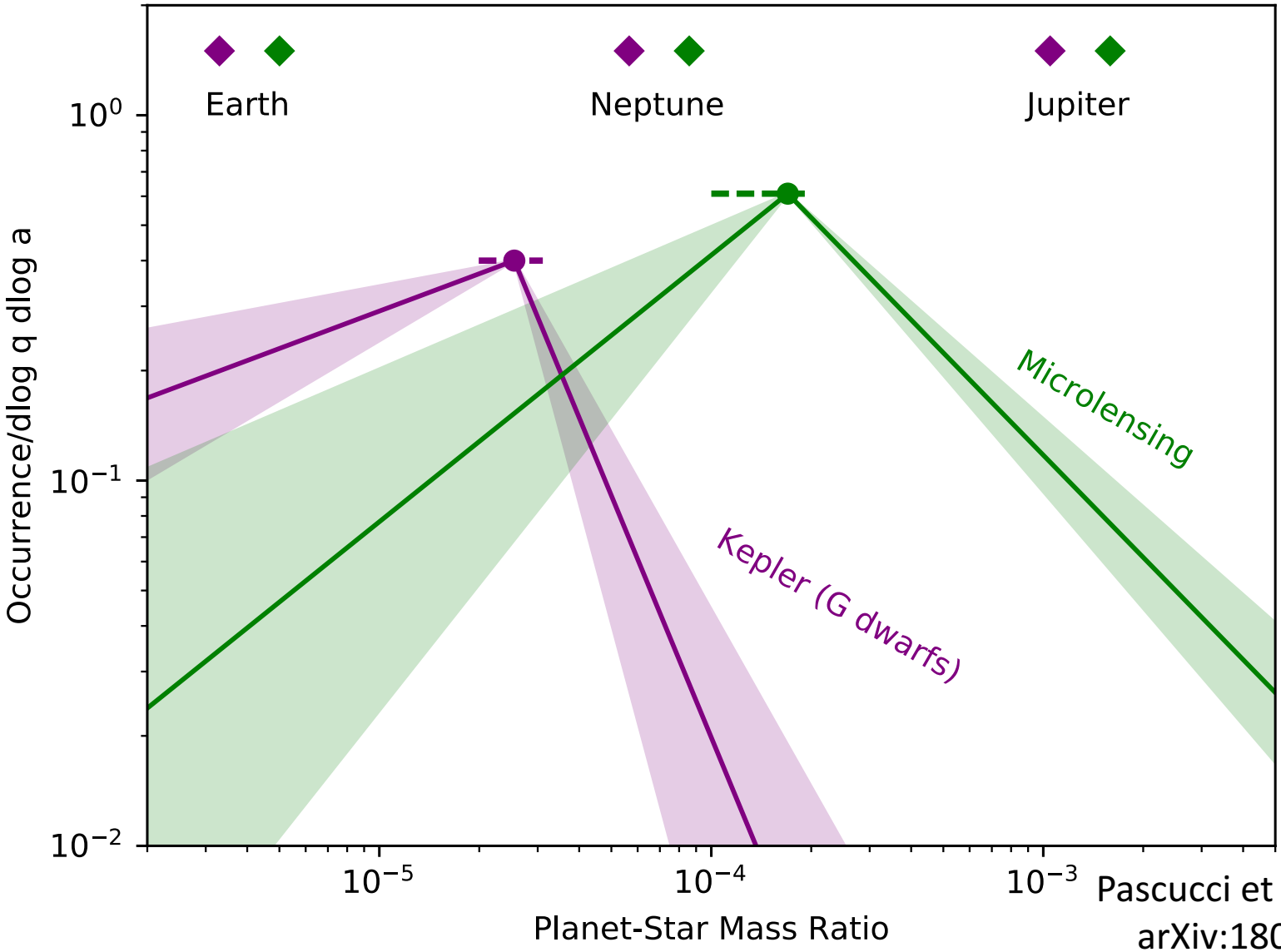
Udalski et al. 2018 arXiv:1802.02582

What will WFIRST tell us about the Mass Ratio Function?

- What is q_{br}?

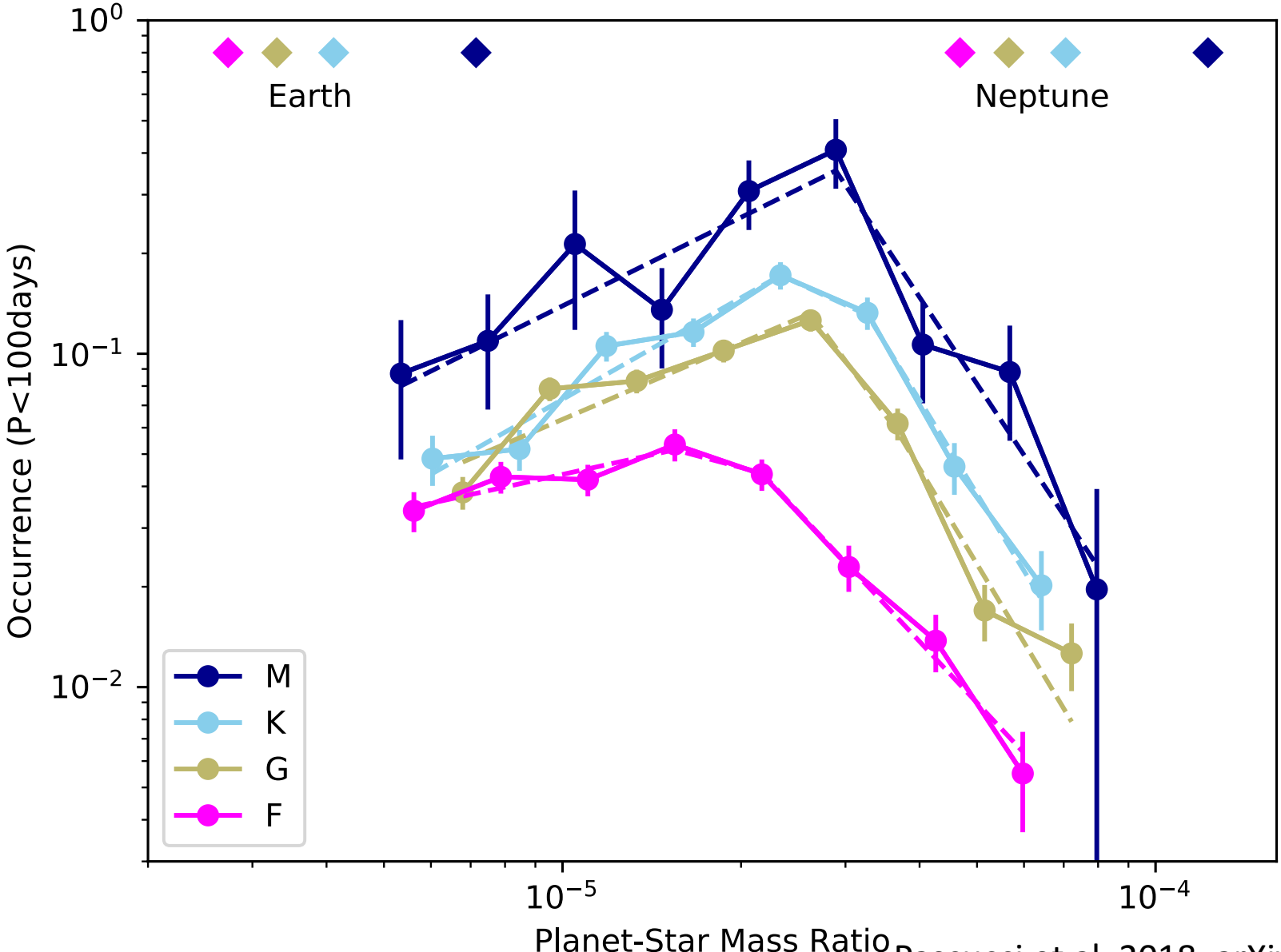


Kepler break is @ smaller q (~3x10^{-5})



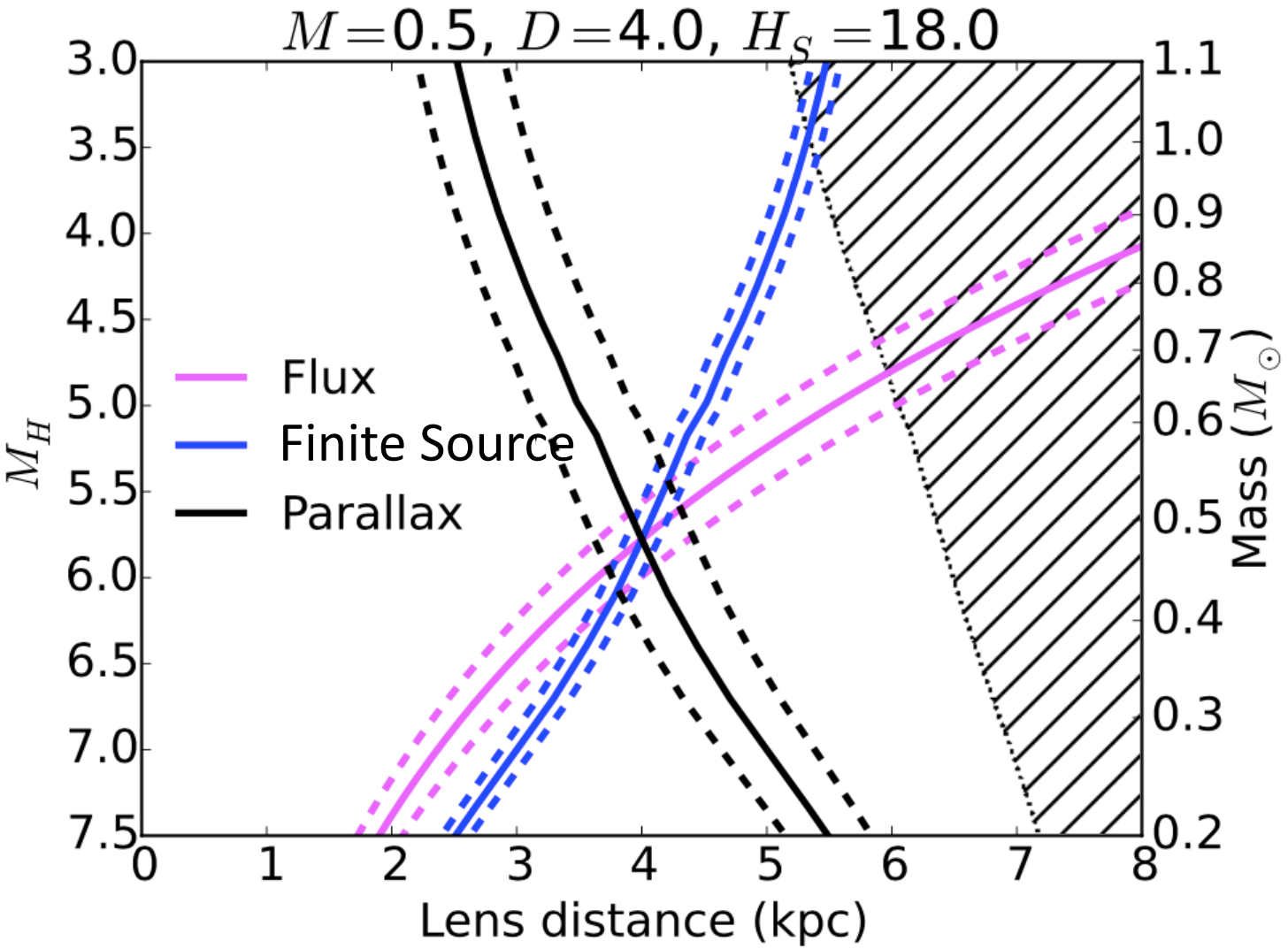
Pascucci et al. 2018, arXiv:1803.00777

q_{br} is independent of Stellar Mass



Pascucci et al. 2018, arXiv:1803.00777

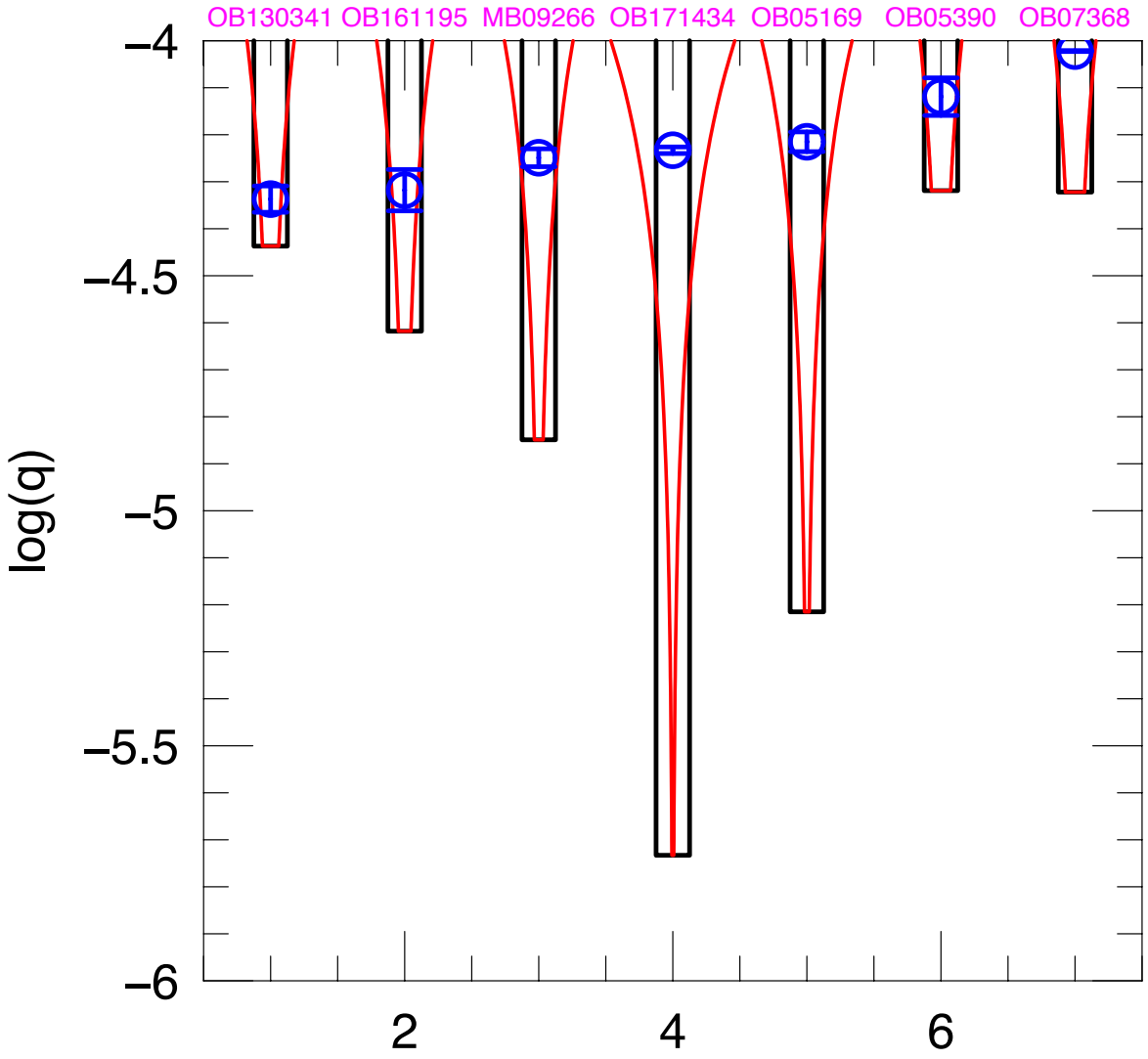
WFIRST can combine many techniques to measure Host Masses



What will WFIRST tell us about the Mass Ratio Function?

- What is q_{br}?
- How does q_{br} vary with semi-major axis?
- How does q_{br} vary with host star mass?

Ground-based microlensing cannot measure the lowest mass ratios.



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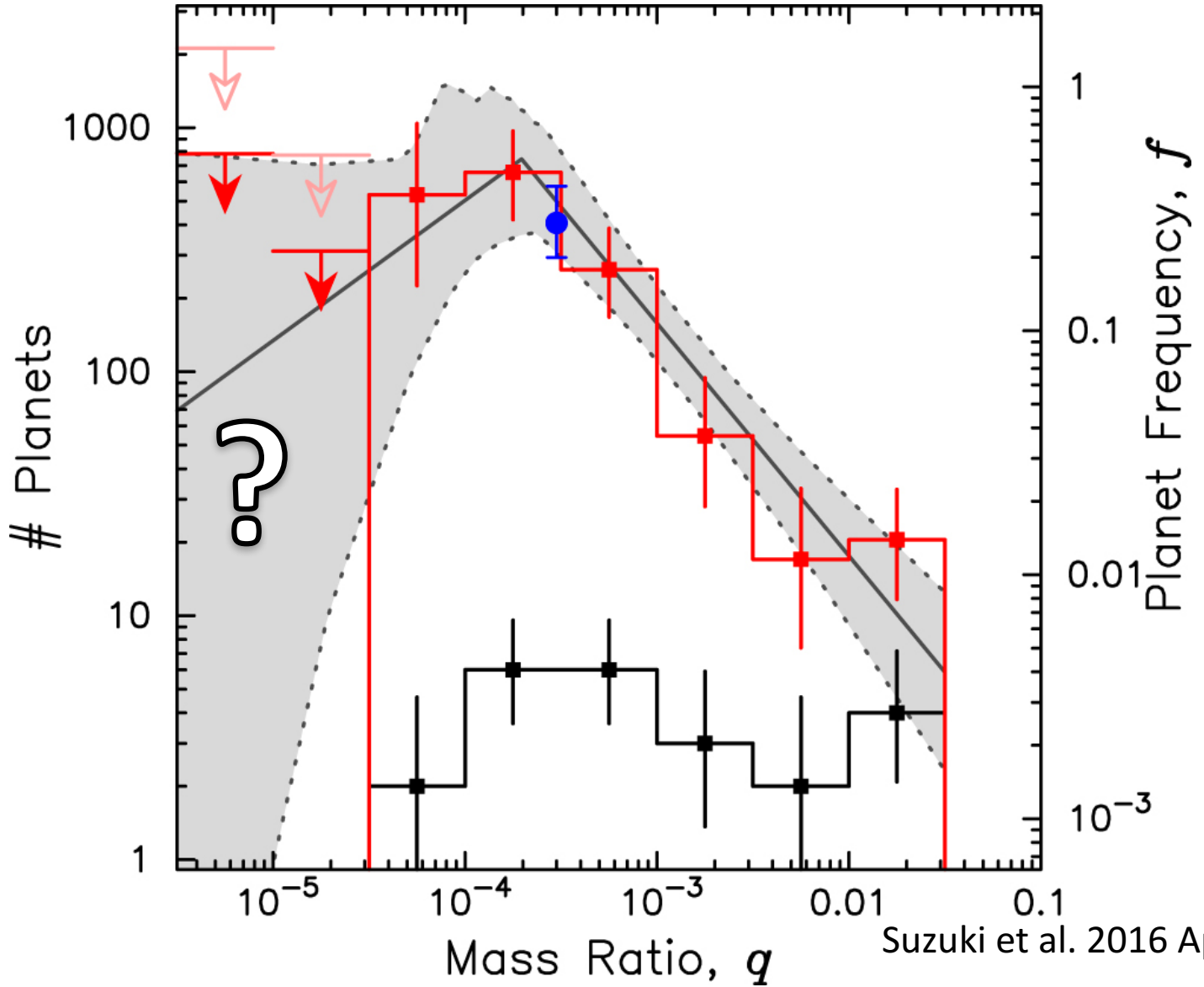
Only WFIRST can measure low mass ratio slope.

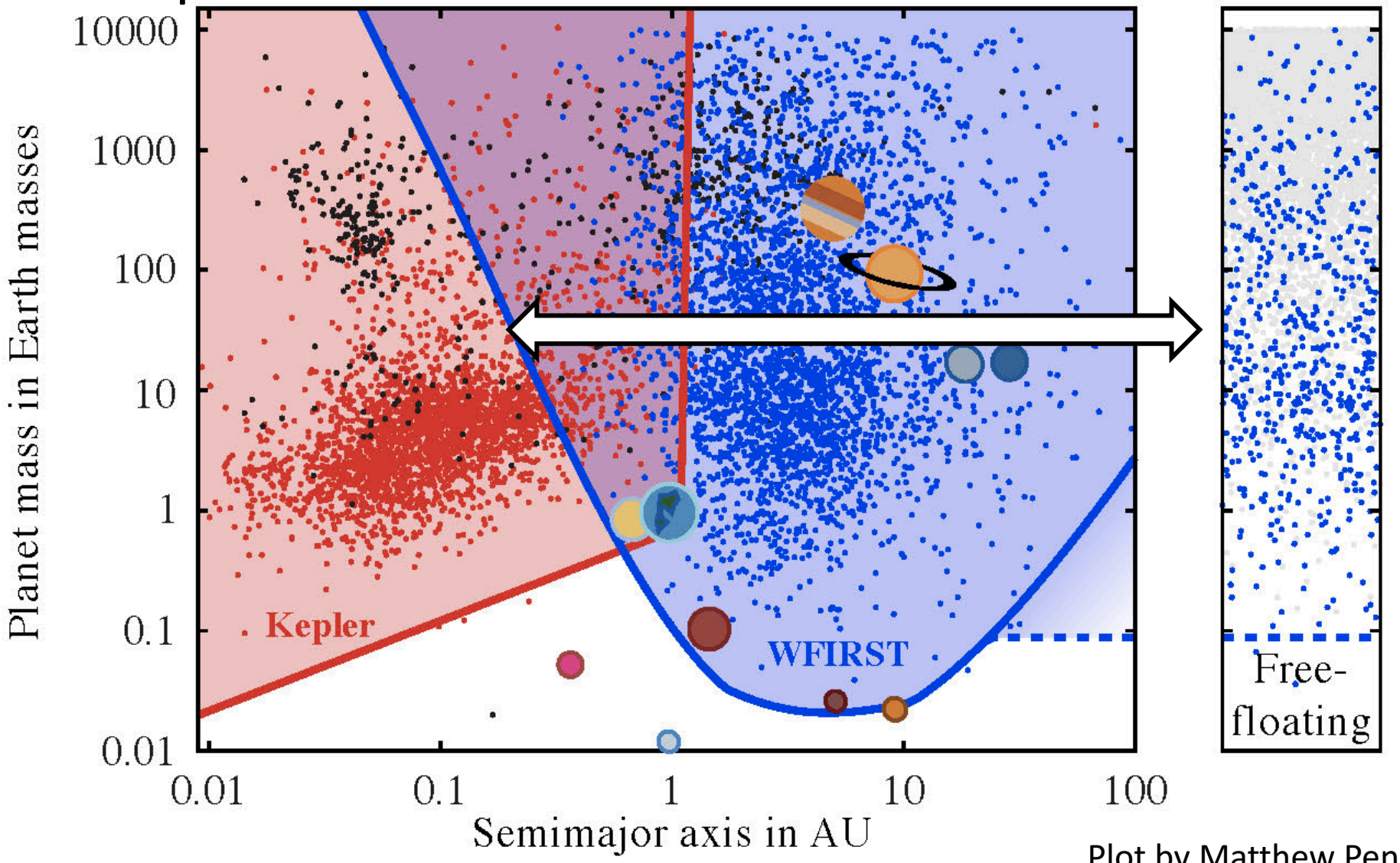


Suzuki et al. 2016 ApJ 833, 145

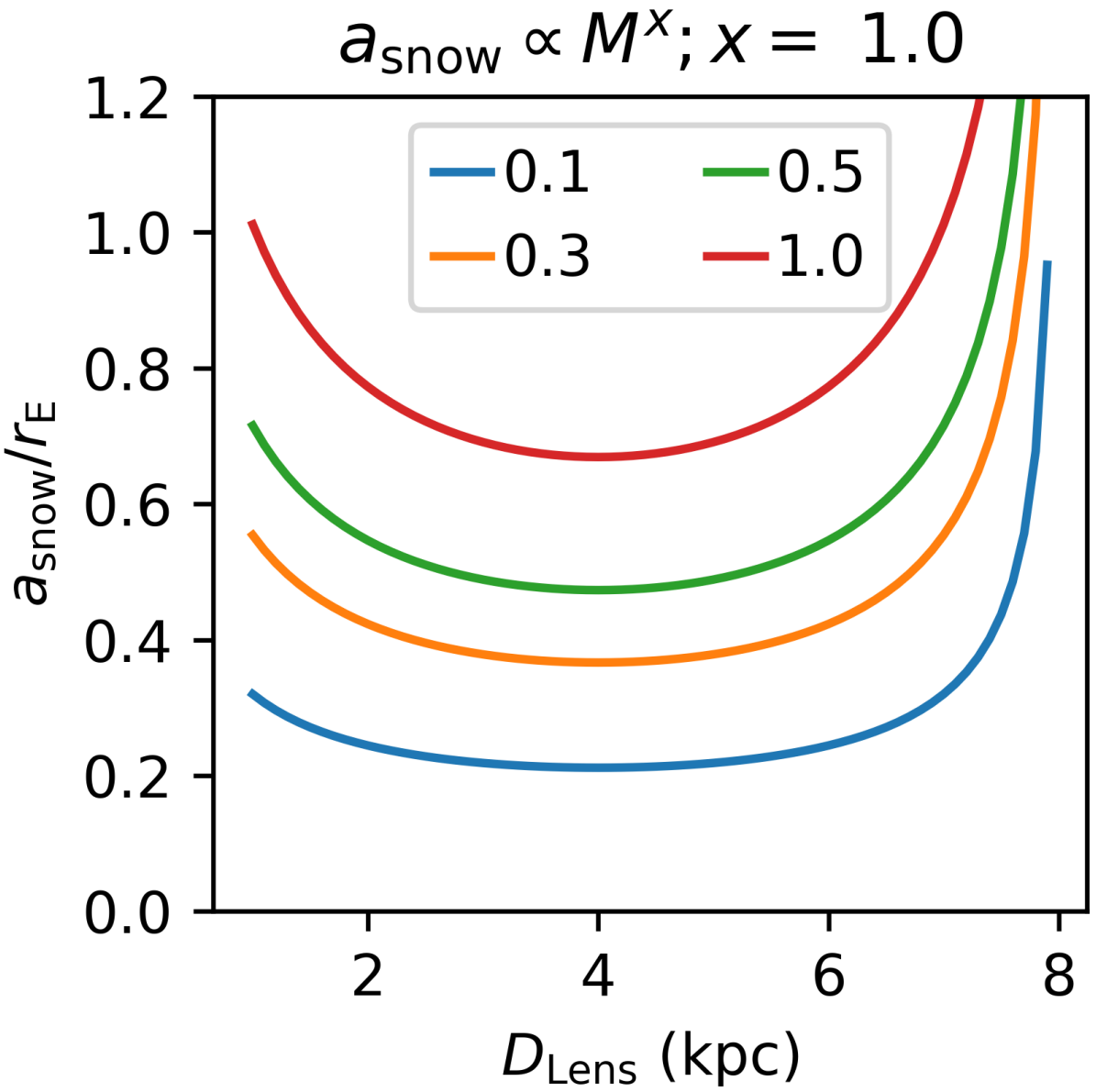
What will WFIRST tell us about the Mass Ratio Function?

- What is q_{br}?
- How does q_{br} vary with semi-major axis?
- How does q_{br} vary with host star mass?
- What is the slope of the mass ratio distribution at small q?

Large planets at a wide range of separations.



Plot by Matthew Penny

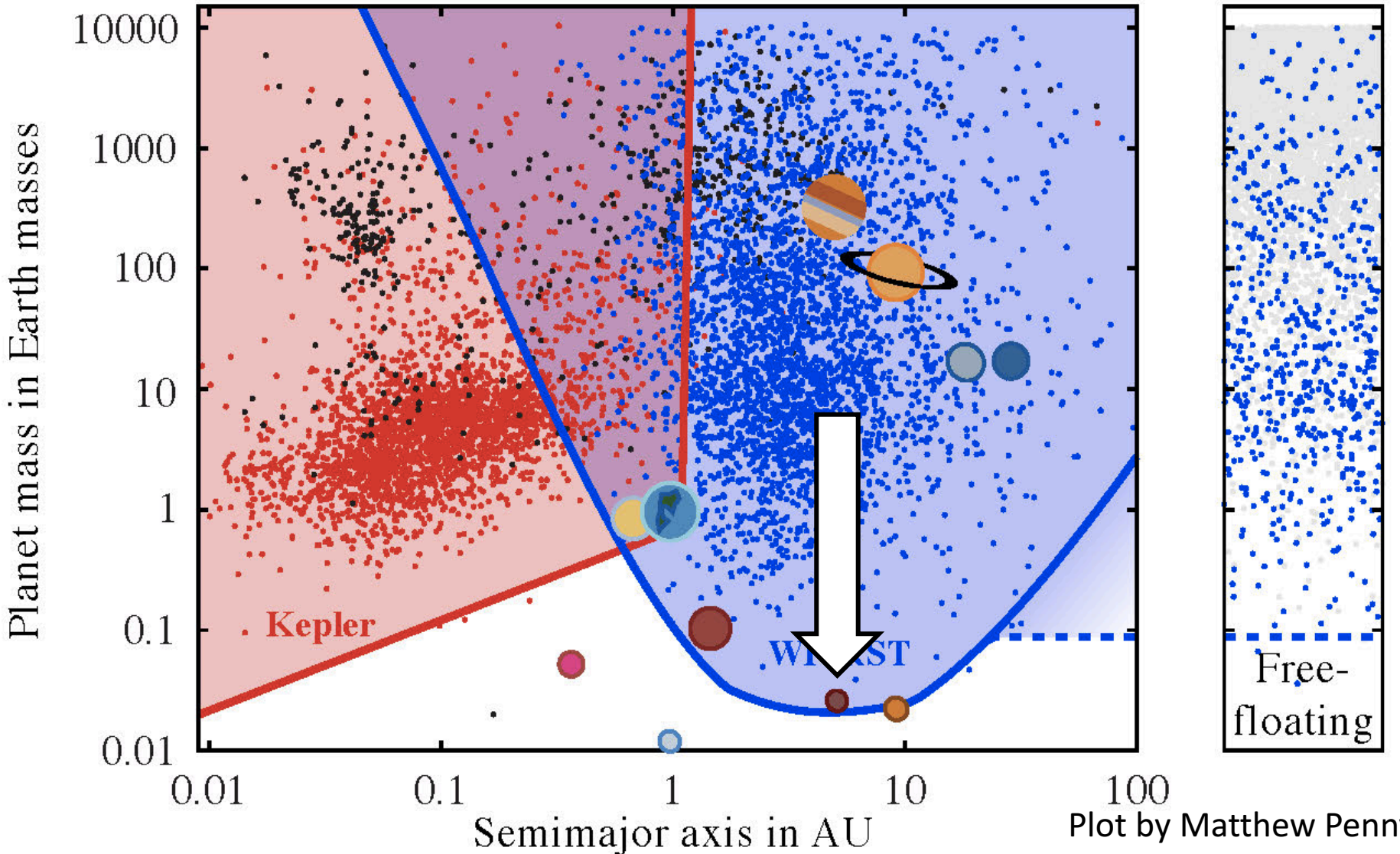

$a_{\rm snow} \propto M^x; x = 1.0$
0.1
0.3
0.5
1.0
1.2
1.0
0.8
0.6
0.4
0.2
0.0
$a_{\rm snow}/r_{\rm E}$
2
4
6
8
$D_{\rm Lens}$ (kpc)

What does the Mass Ratio Function tell us about Physics?

- Where is the snow line?
- How does the snow line depend on stellar mass?
- Is the snow line fuzzy or sharp?

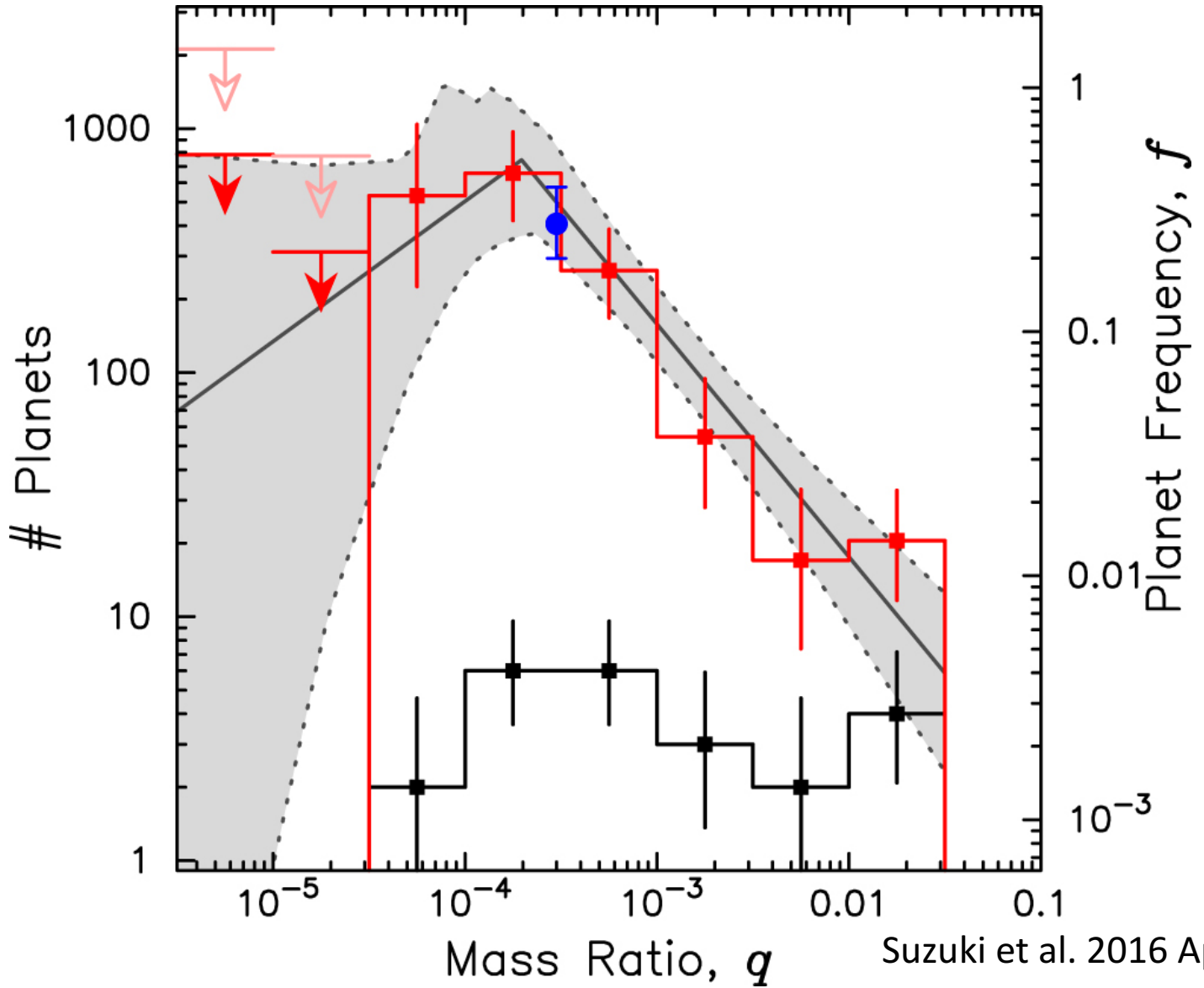
The Leftovers of Planet Formation

Ganymede-sized planets outside the snow line.



Plot by Matthew Penny

Are there other features at low mass ratios?

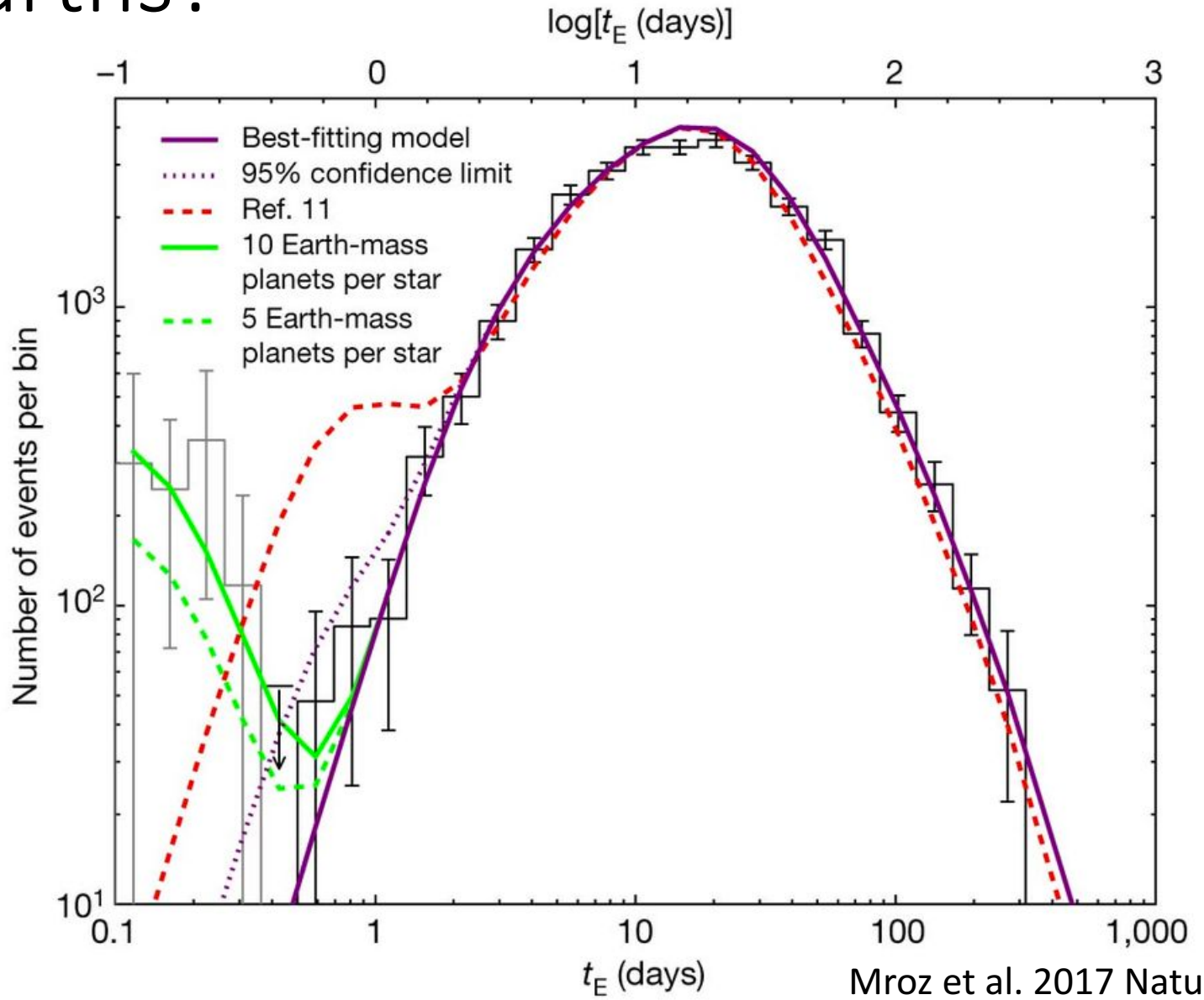


Suzuki et al. 2016 ApJ 833, 145

What will WFIRST tell us about the Smallest Planets?

- What does the mass (ratio) distribution look like for small q? Is there a feature at Mars mass?

Population of Free-Floating Super Earths?

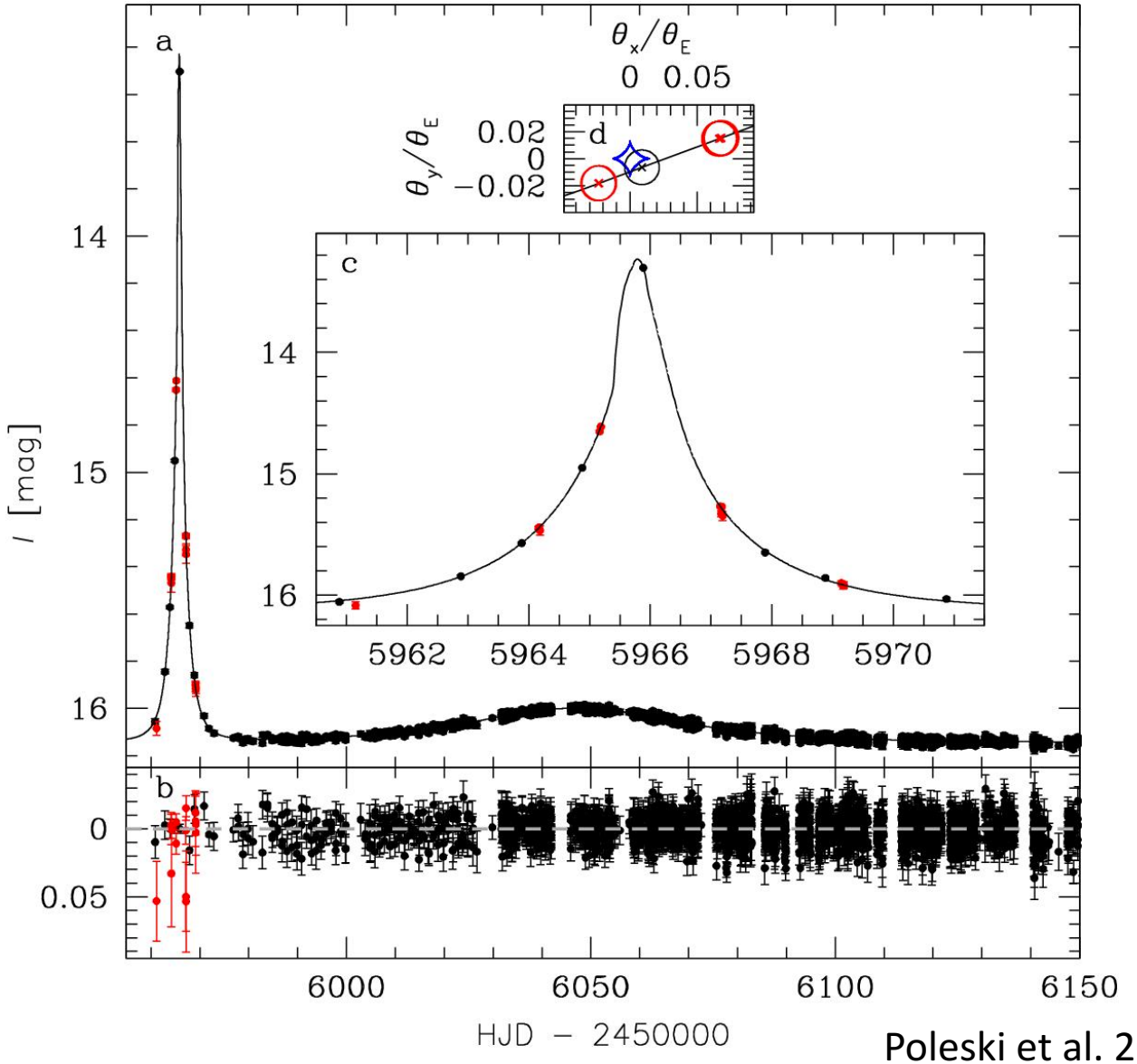


Mroz et al. 2017 Nature 548, 183

What will WFIRST tell us about the Smallest Planets?

- What does the mass (ratio) distribution look like for small q? Is there a feature at Mars mass?
- What is the mass spectrum of free-floating planets?

Are Free-Floating Planets bound?



Poleski et al. 2017, A&A 604, 103

What will WFIRST tell us about the Smallest Planets?

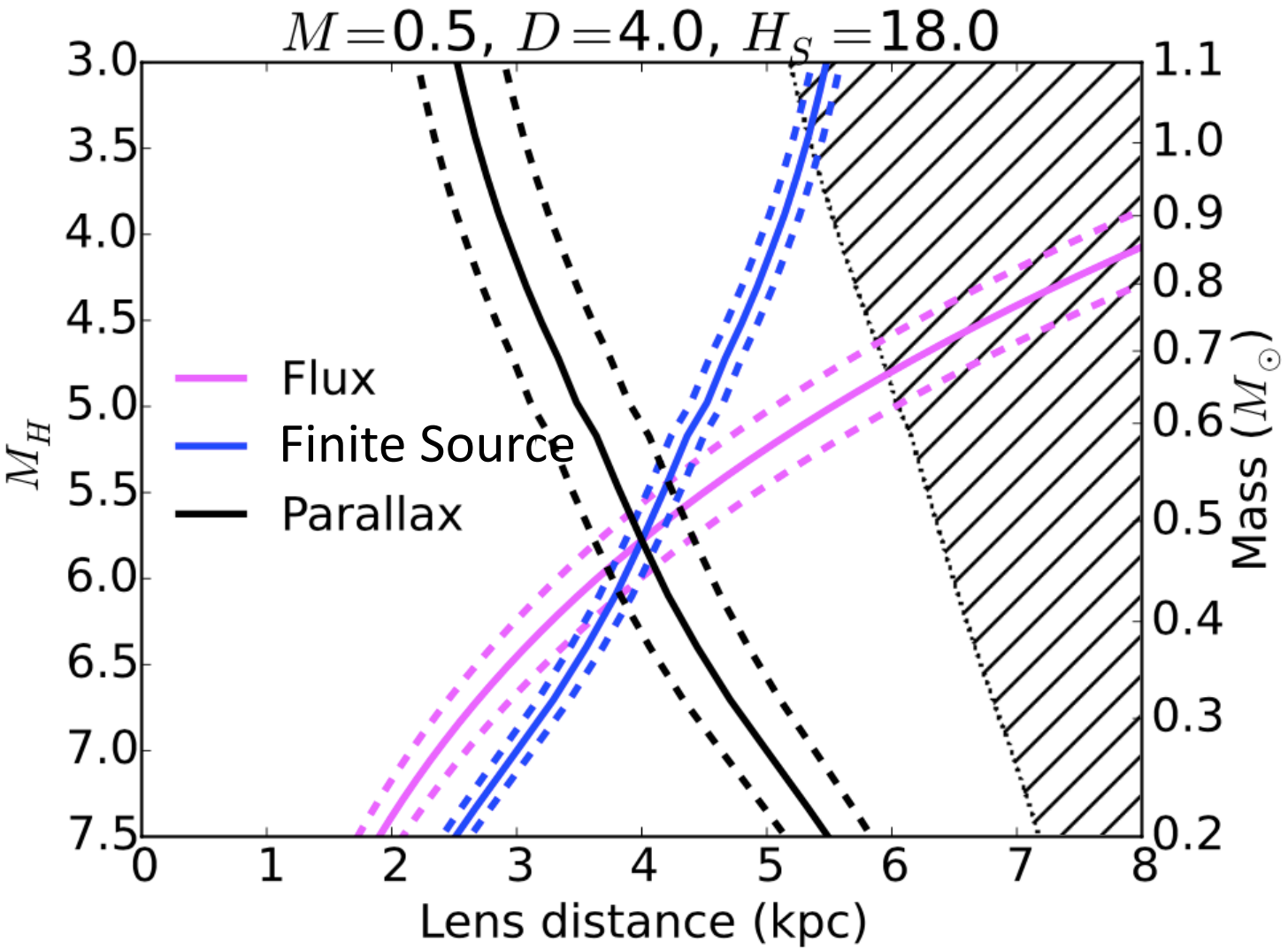
- What does the mass (ratio) distribution look like for small q? Is there a feature at Mars mass?
- What is the mass spectrum of free-floating planets?
- How do free-floating planets relate to bound planets? Are free-floating planets really free-floating?

What do the Smallest Planets tell us about Planet Formation?

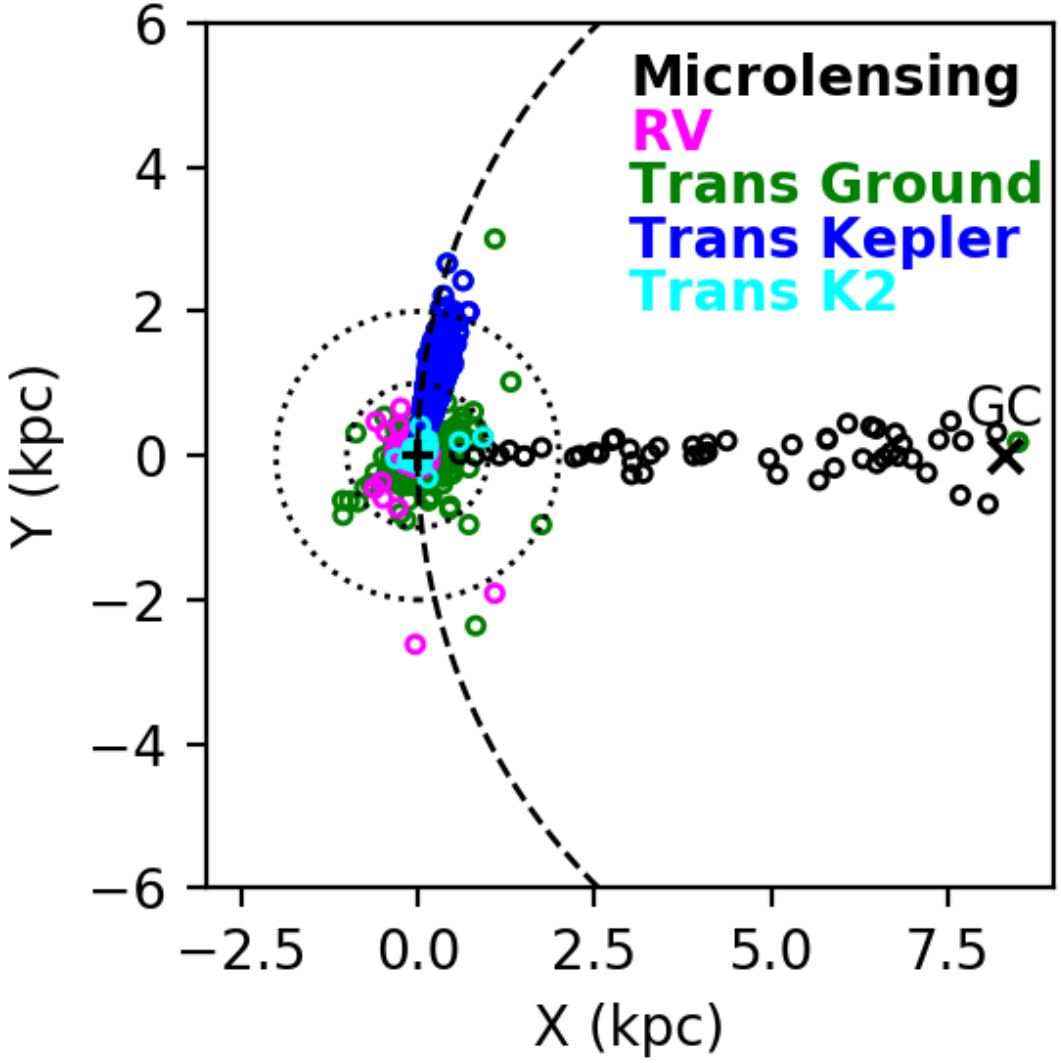
- How efficient is planet formation?
- What is leftover from planet formation?
- What is ejected during planet formation?

The Galactic Distribution of Planets

A Mass Measurement = Distance Measurement



Microlensing finds planets from 0—8 kpc.

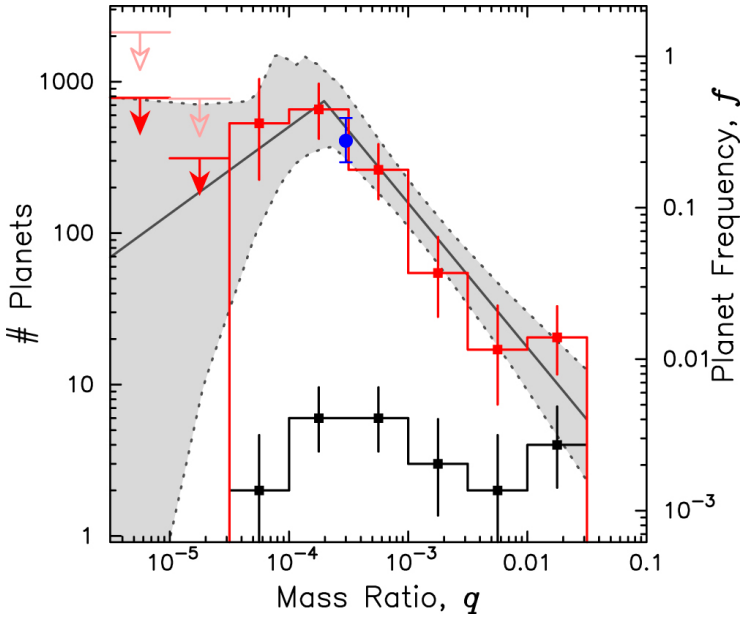


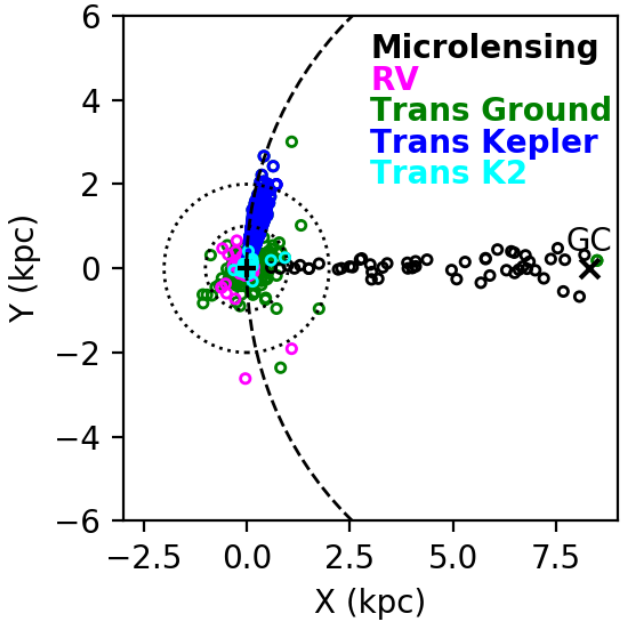
- How do planets vary with galactic distance?

- How does planet formation vary with galactic location?

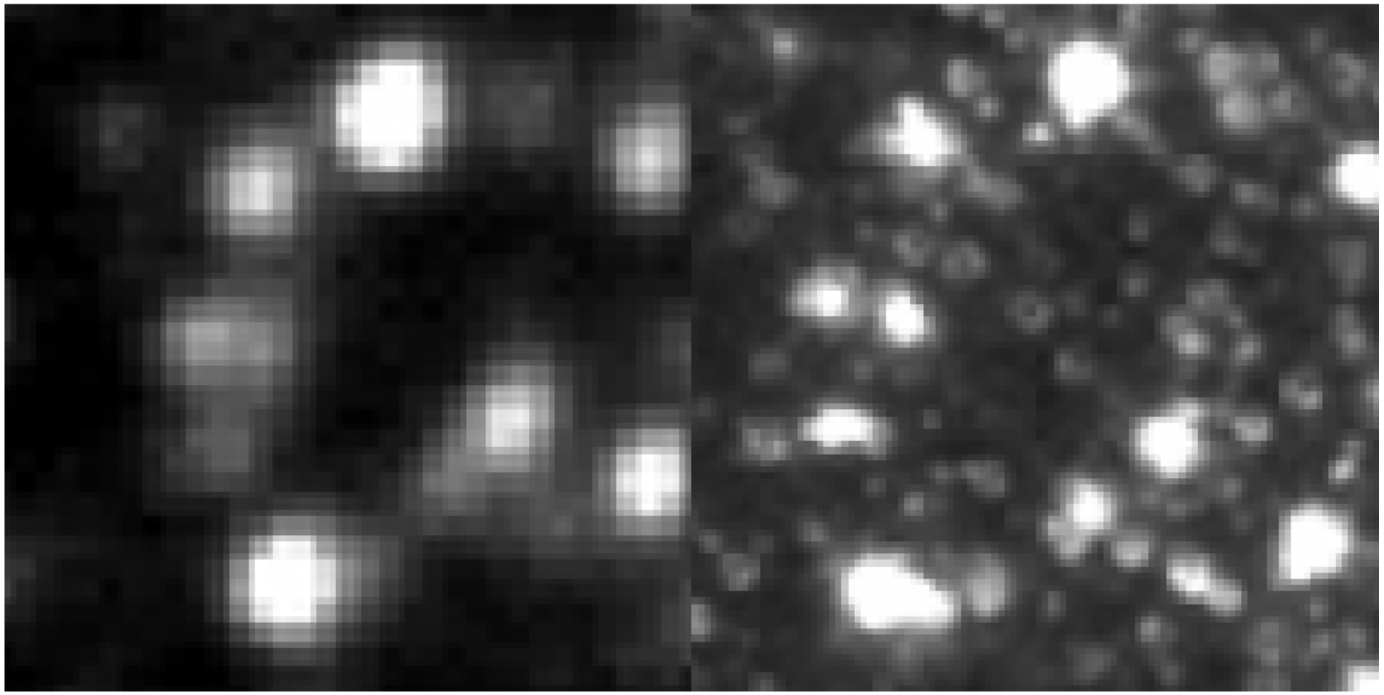
Planet Formation Physics from a Complete Census

- Snow Line Physics
- Planet Embryos & Planet Ejection
- Galactic Distribution of Planets

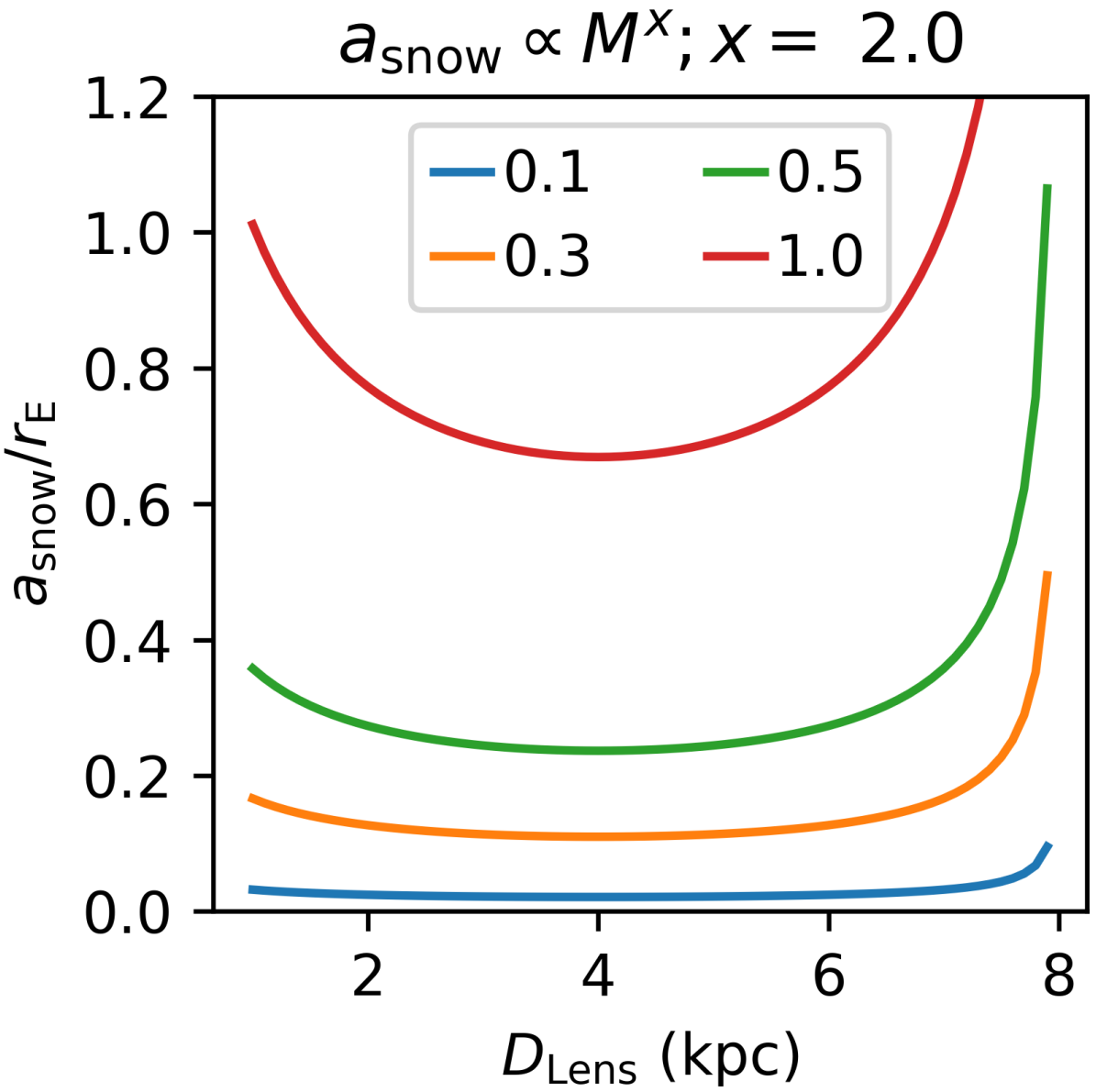




WFIRST will resolve many microlensing events.



Ground HST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0.1
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$D_{\rm Lens}$ (kpc)
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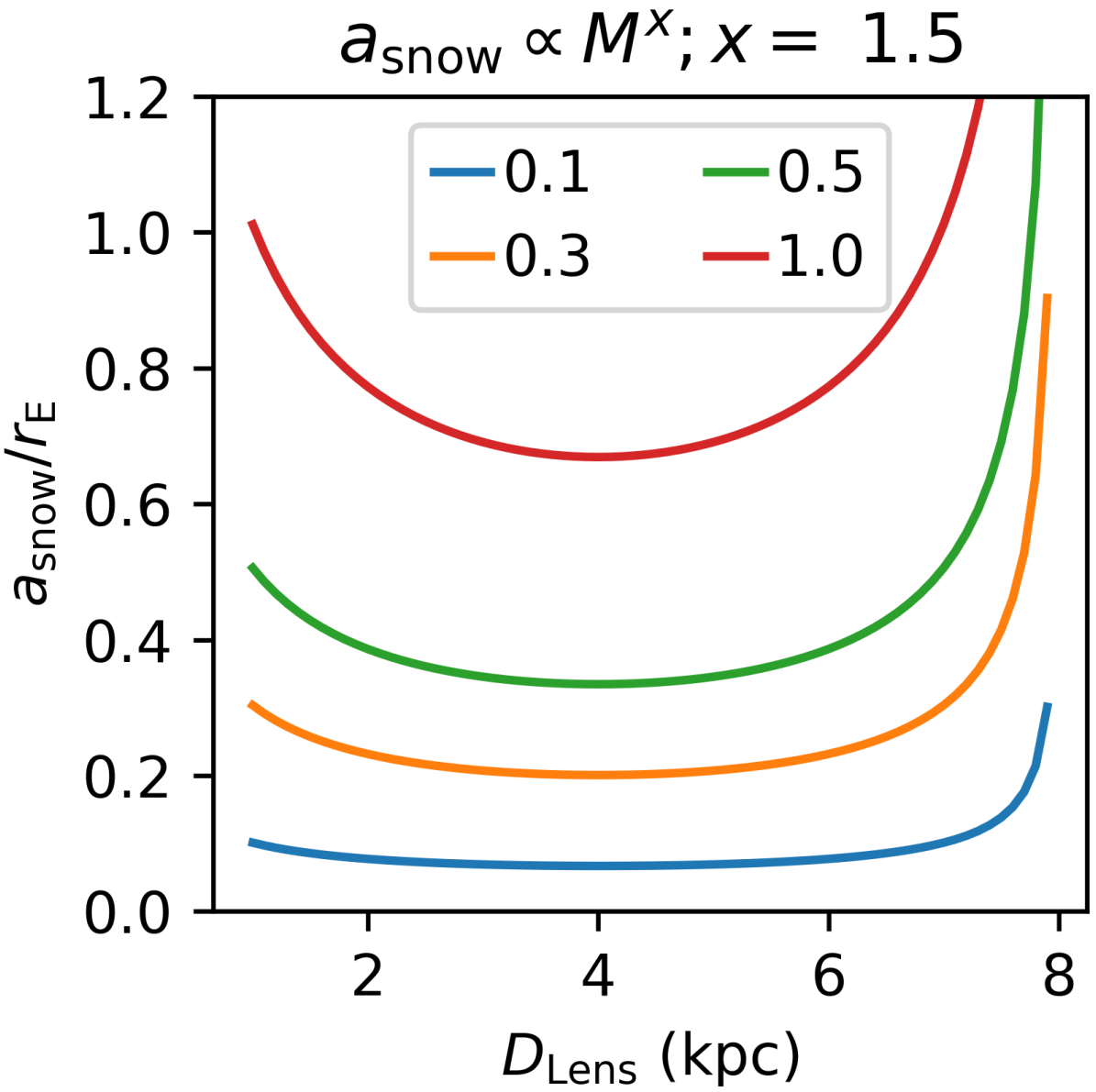
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0.1
0.3
0.5
1.0
$a_{\rm snow}/r_{\rm E}$
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0.2
0.4
0.6
0.8
1.0
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