The Occurrence Rate of Giant Planets around M Dwarfs

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@benmontet

MEASURING THE GALACTIC DISTRIBUTION OF TRANSITING PLANETS WITH *WFIRST*

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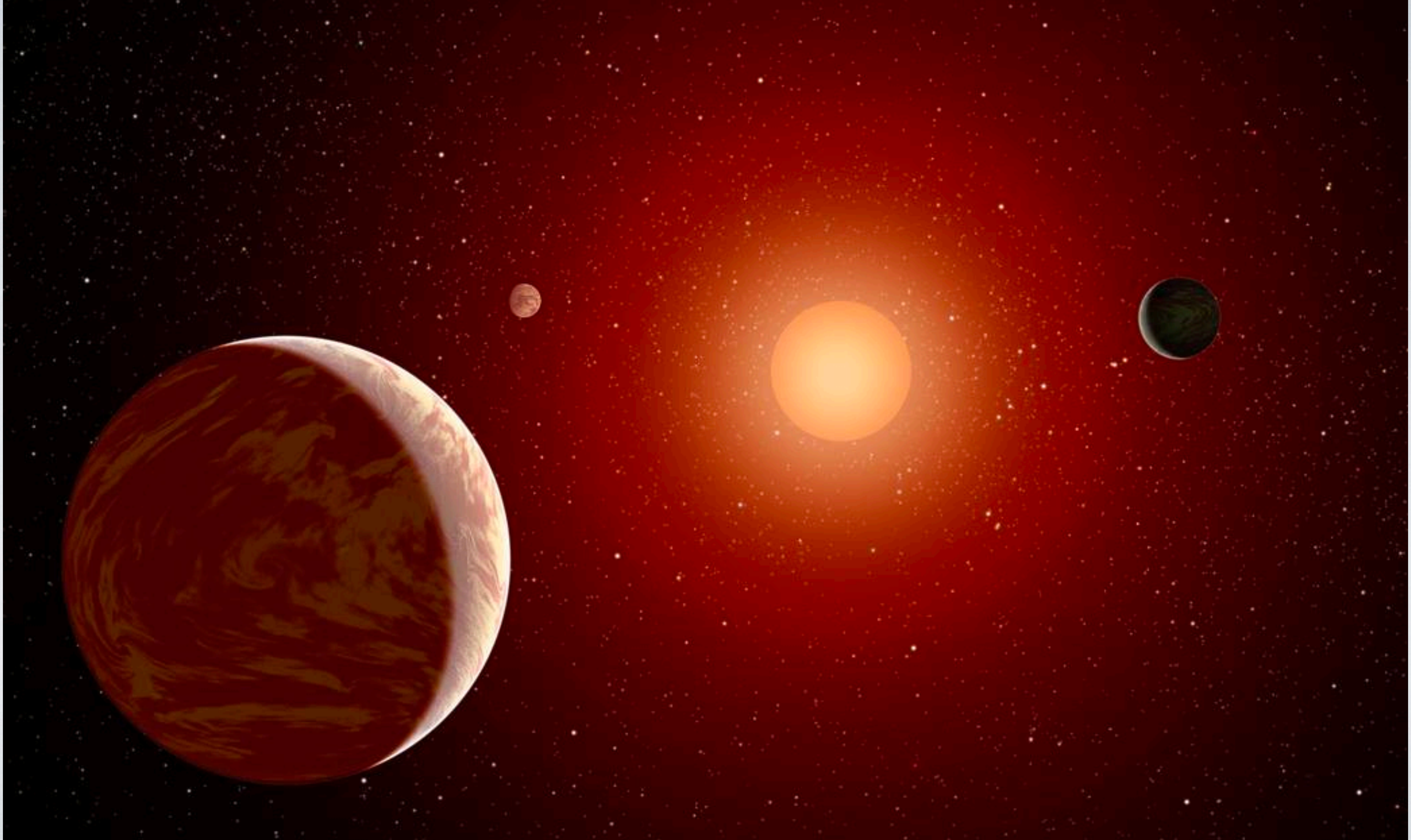
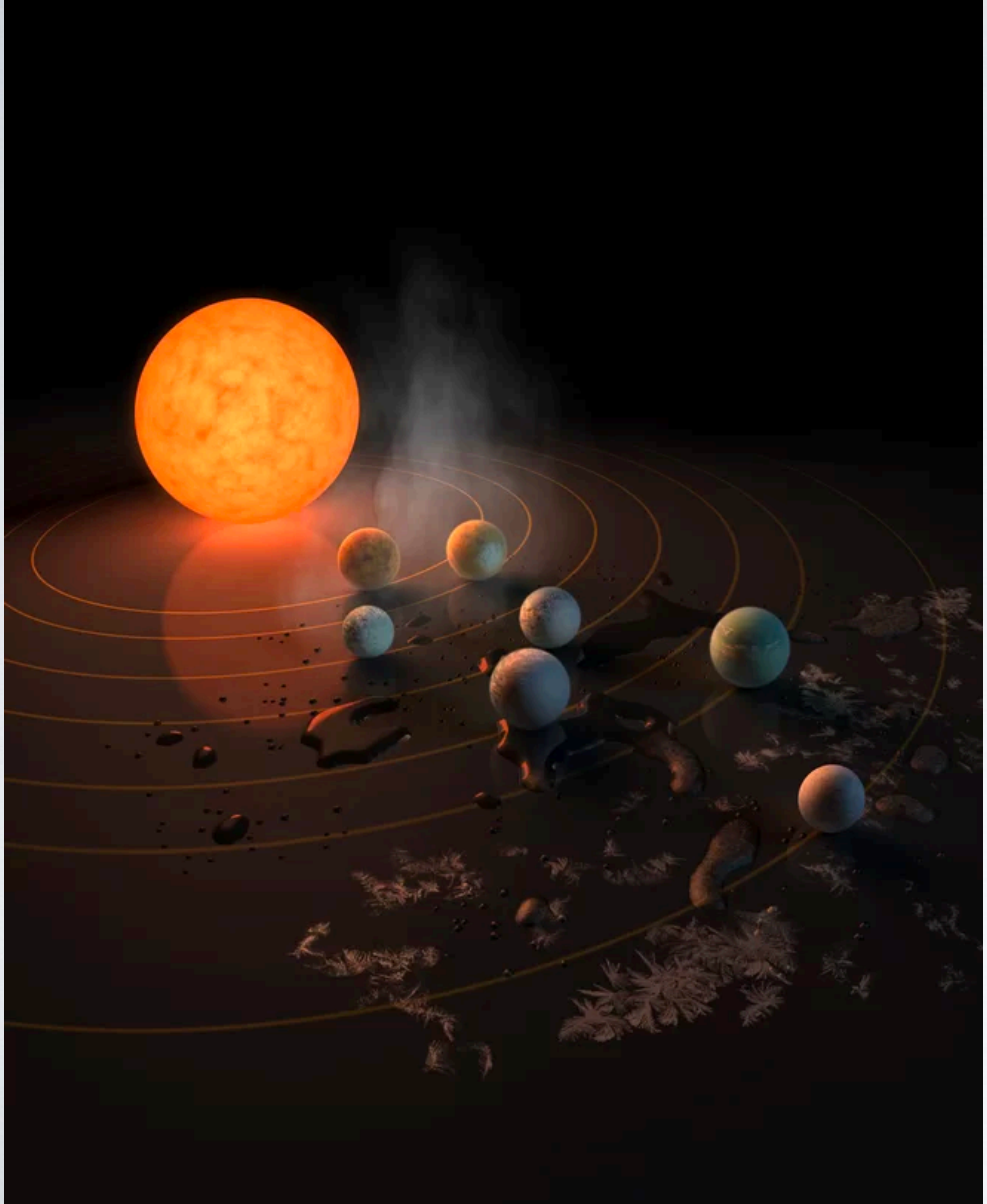
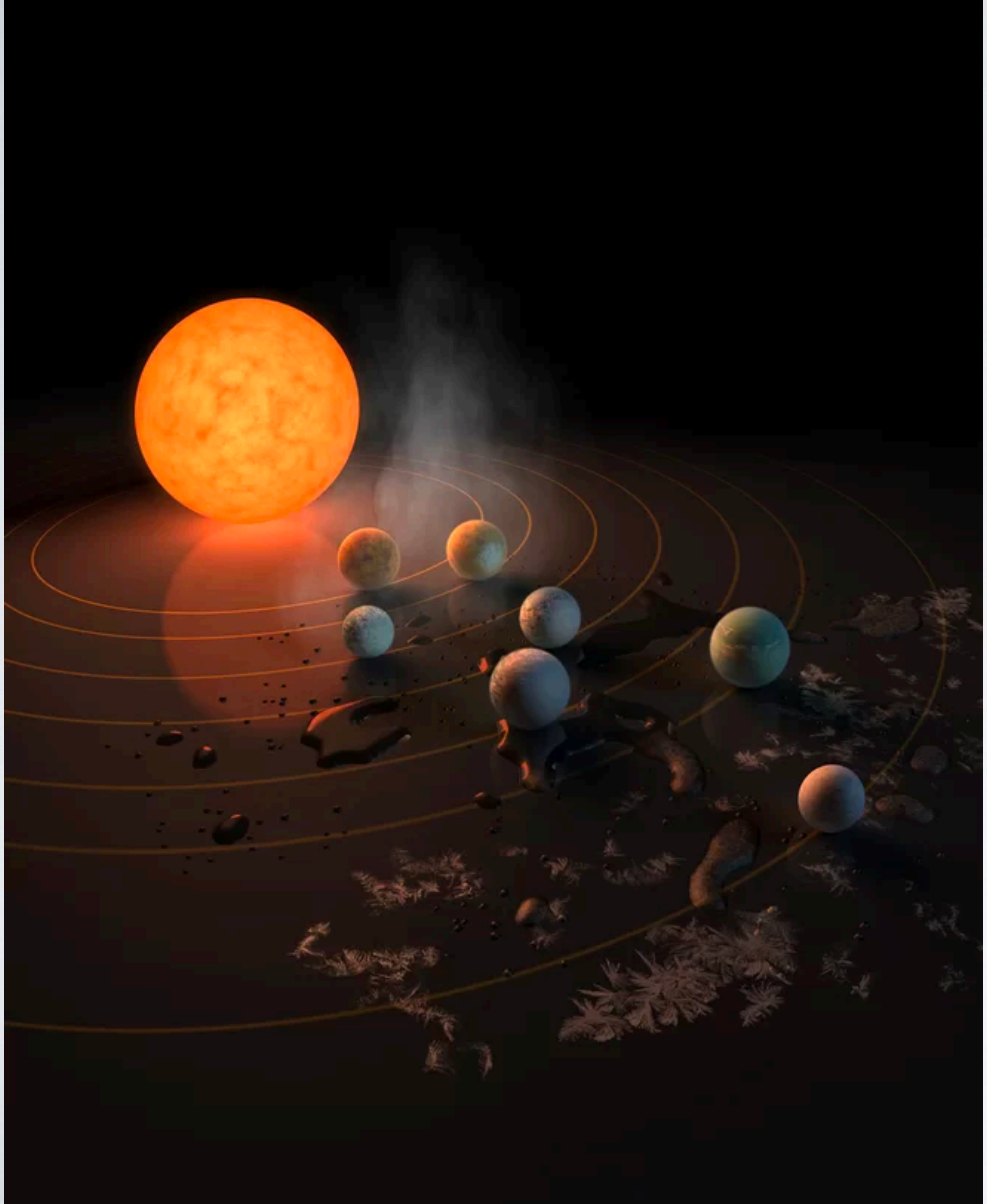
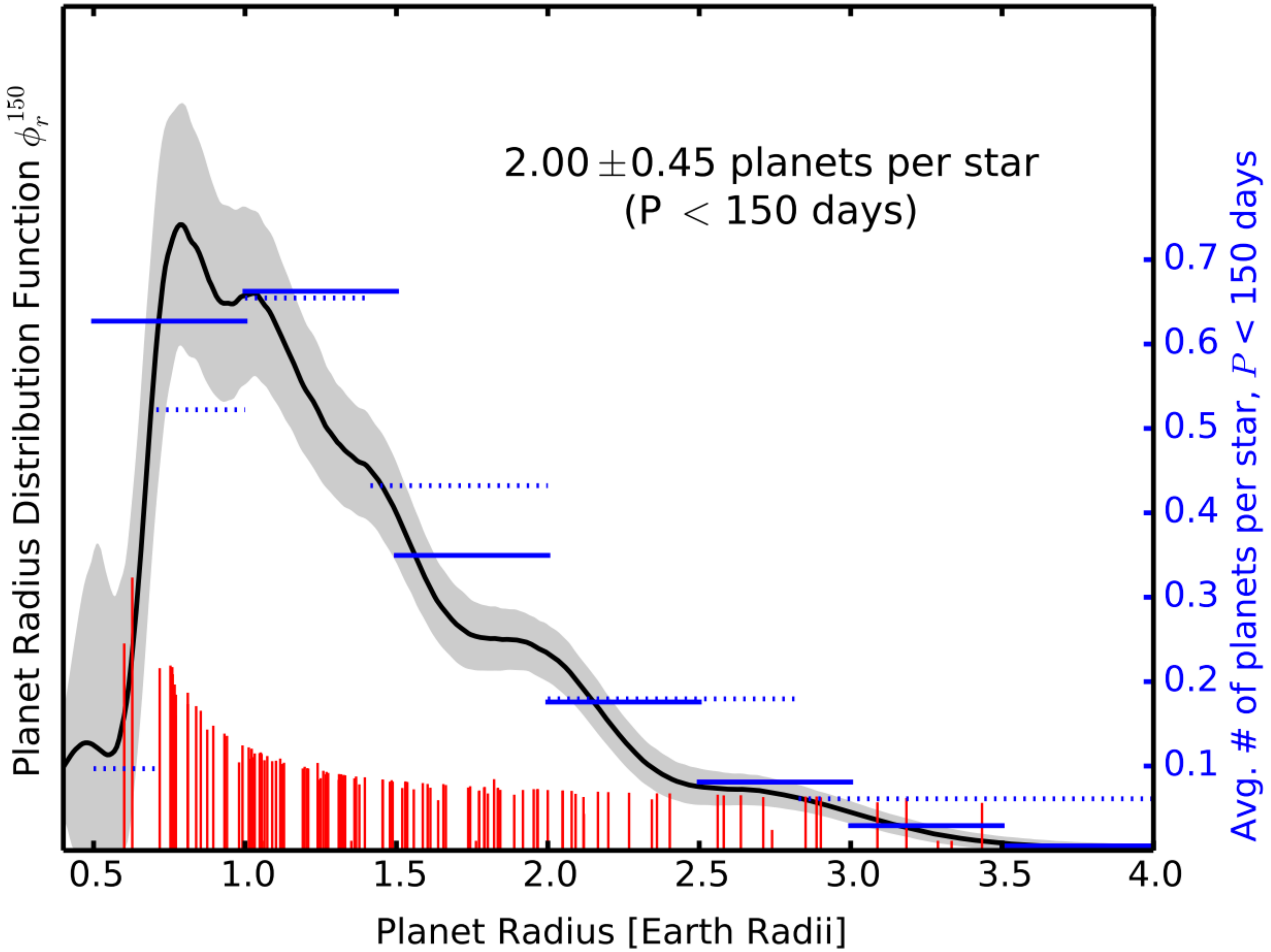
arXiv:1610.03067







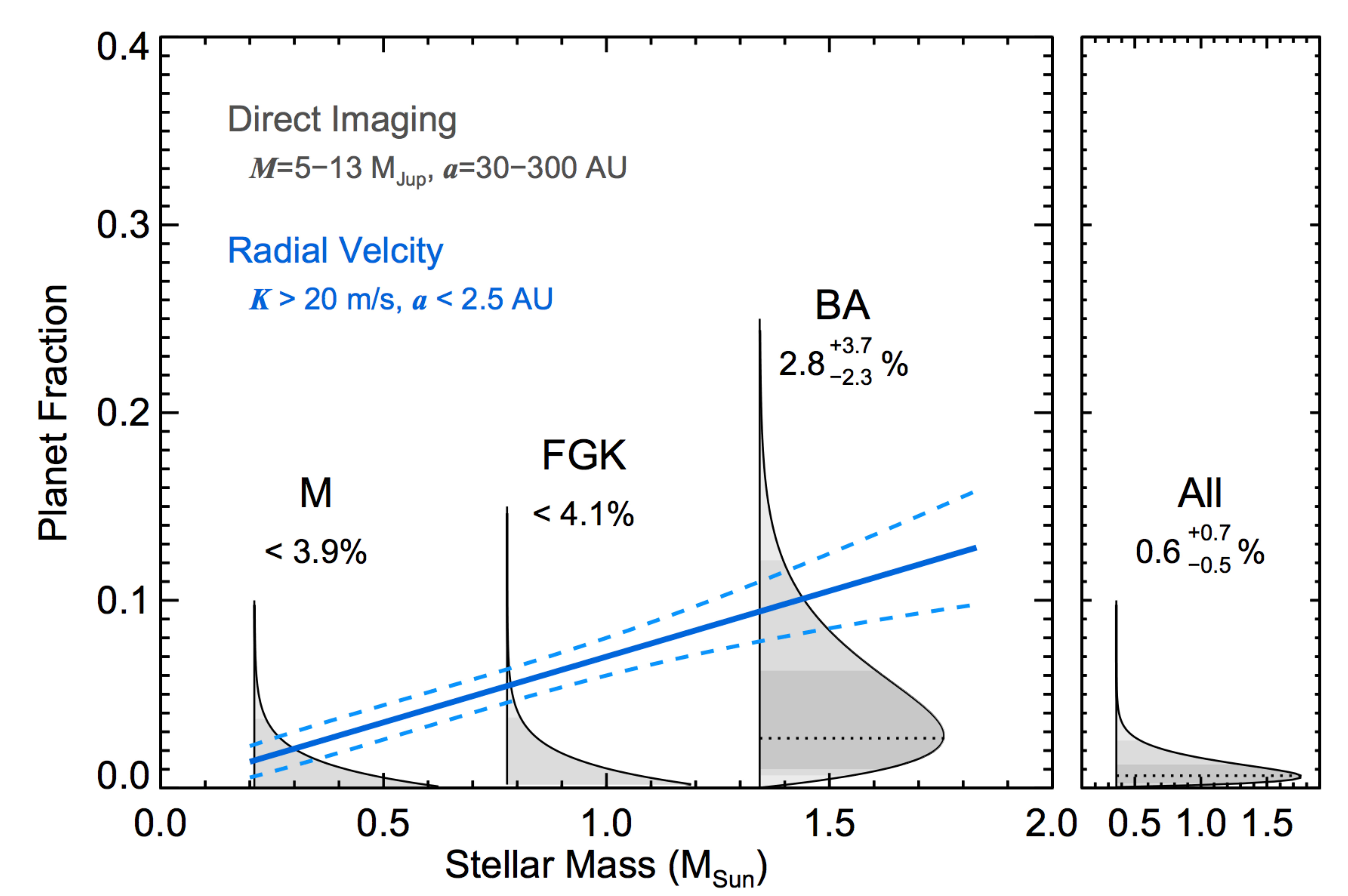
Most planets orbiting M dwarfs are small



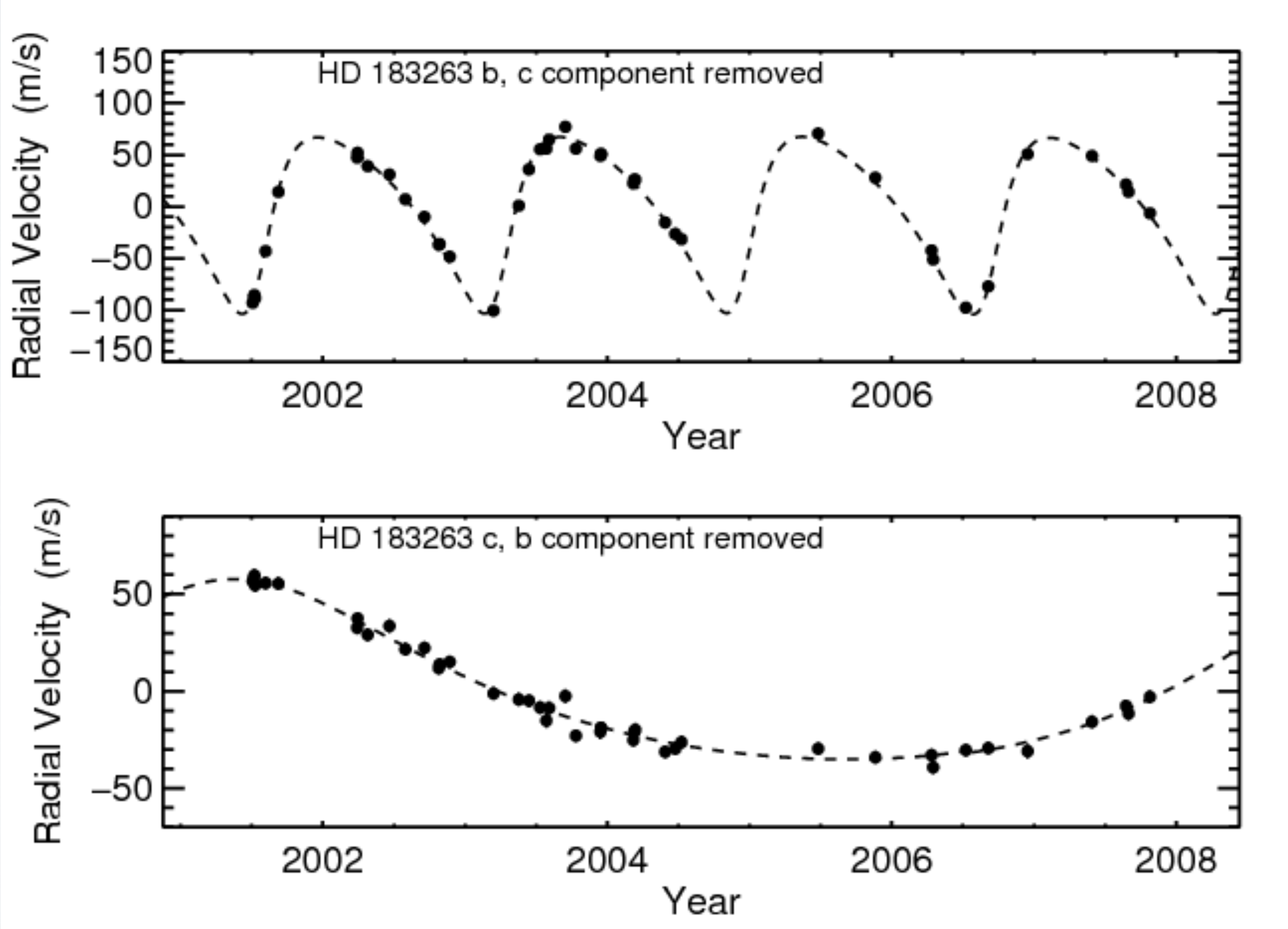
Morton and Swift (2014)

What about planets in wider orbits?

Direct imaging provides upper limits on giant planet occurrence



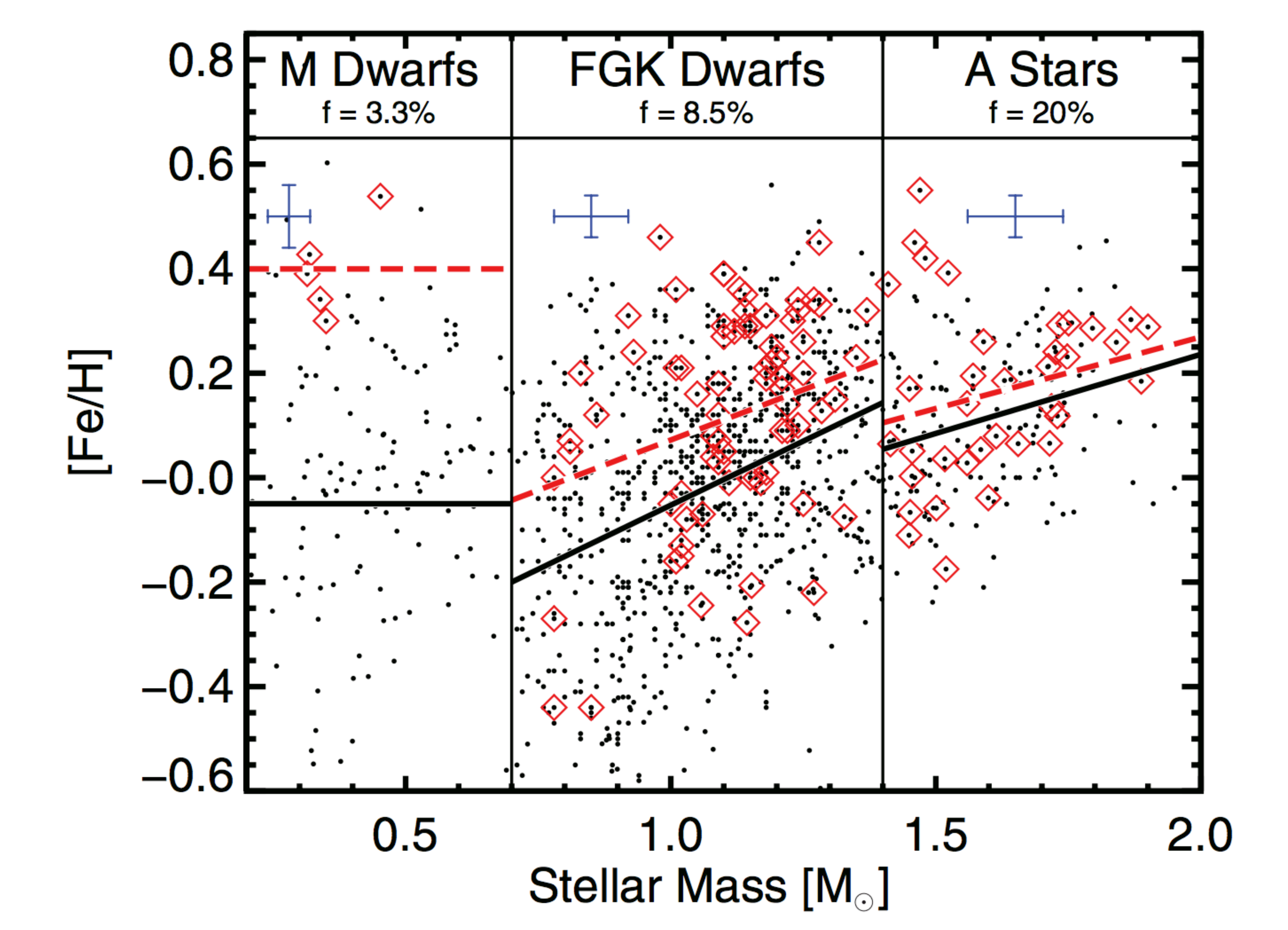
Bowler et al. 2016



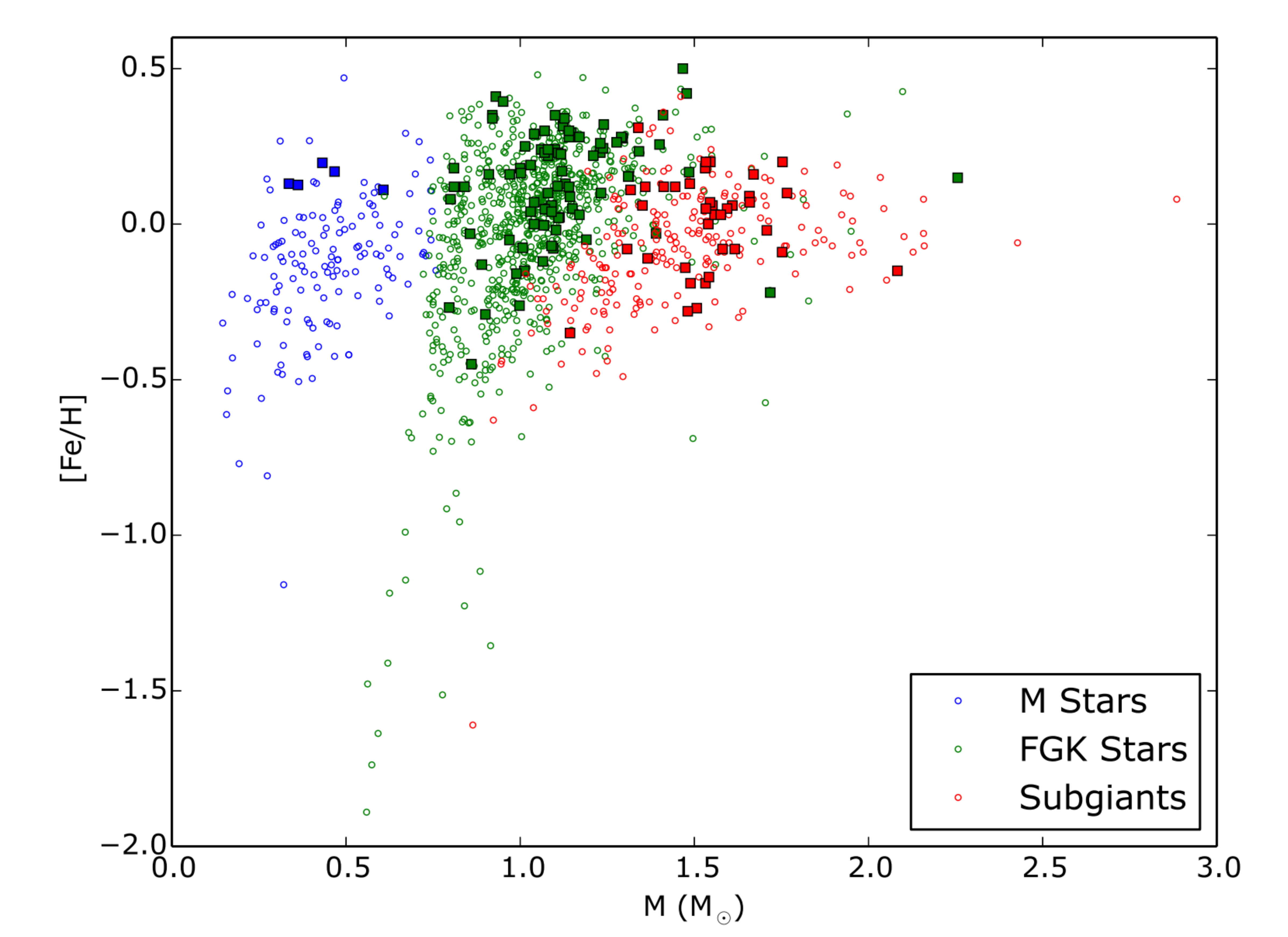
Radial Velocity data provides a multi-year baseline

Wright et al. 2009

RVs show giant planets are rare around M dwarfs



Johnson et al. 2010

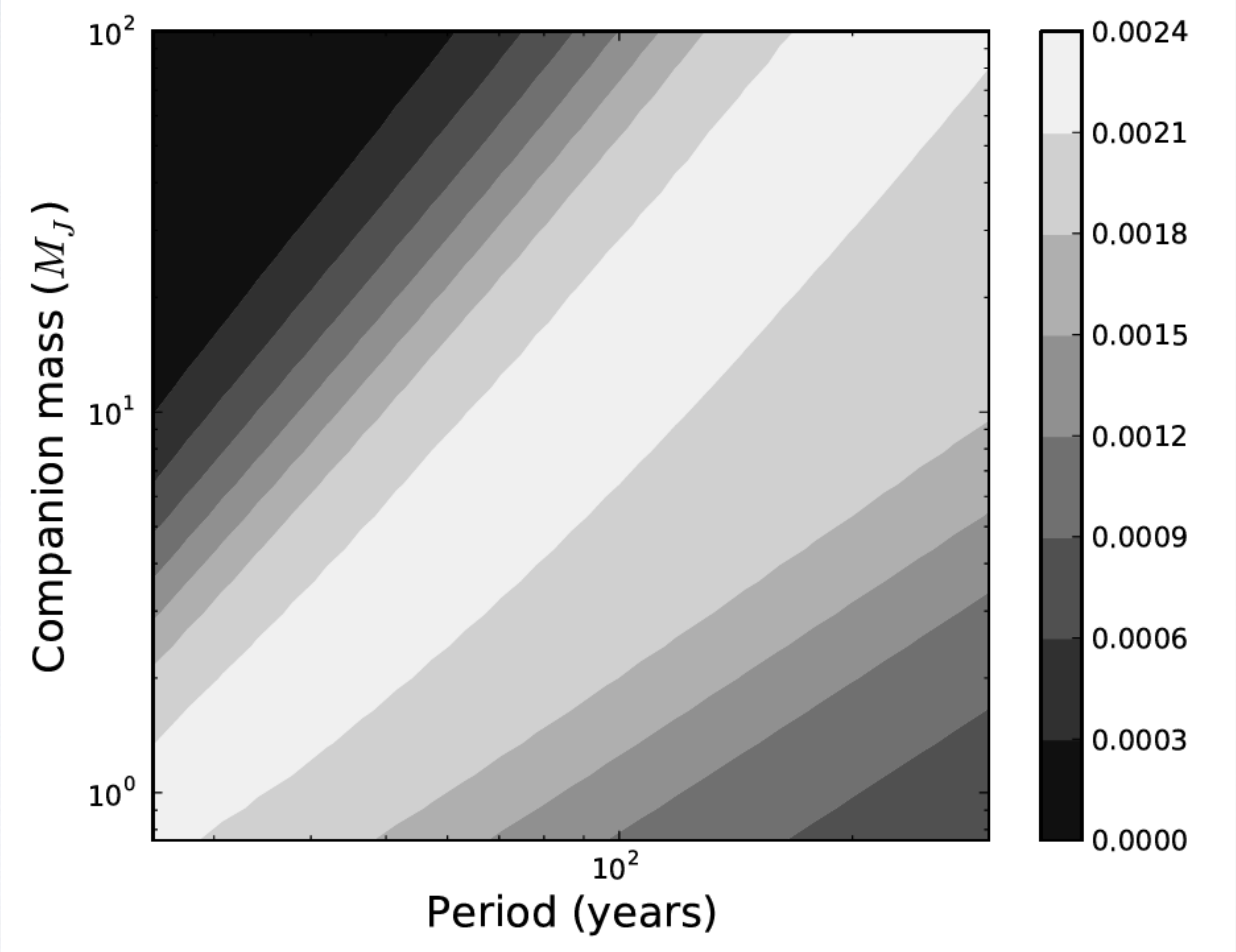


Ghezzi et al. 2018

Long-term RV accelerations provide even more information

Crepp et al. 2012

With a "trend," companion mass, period are degenerate



The companion has lots of room to hide

What if we don’t see the companion?

We still have information!

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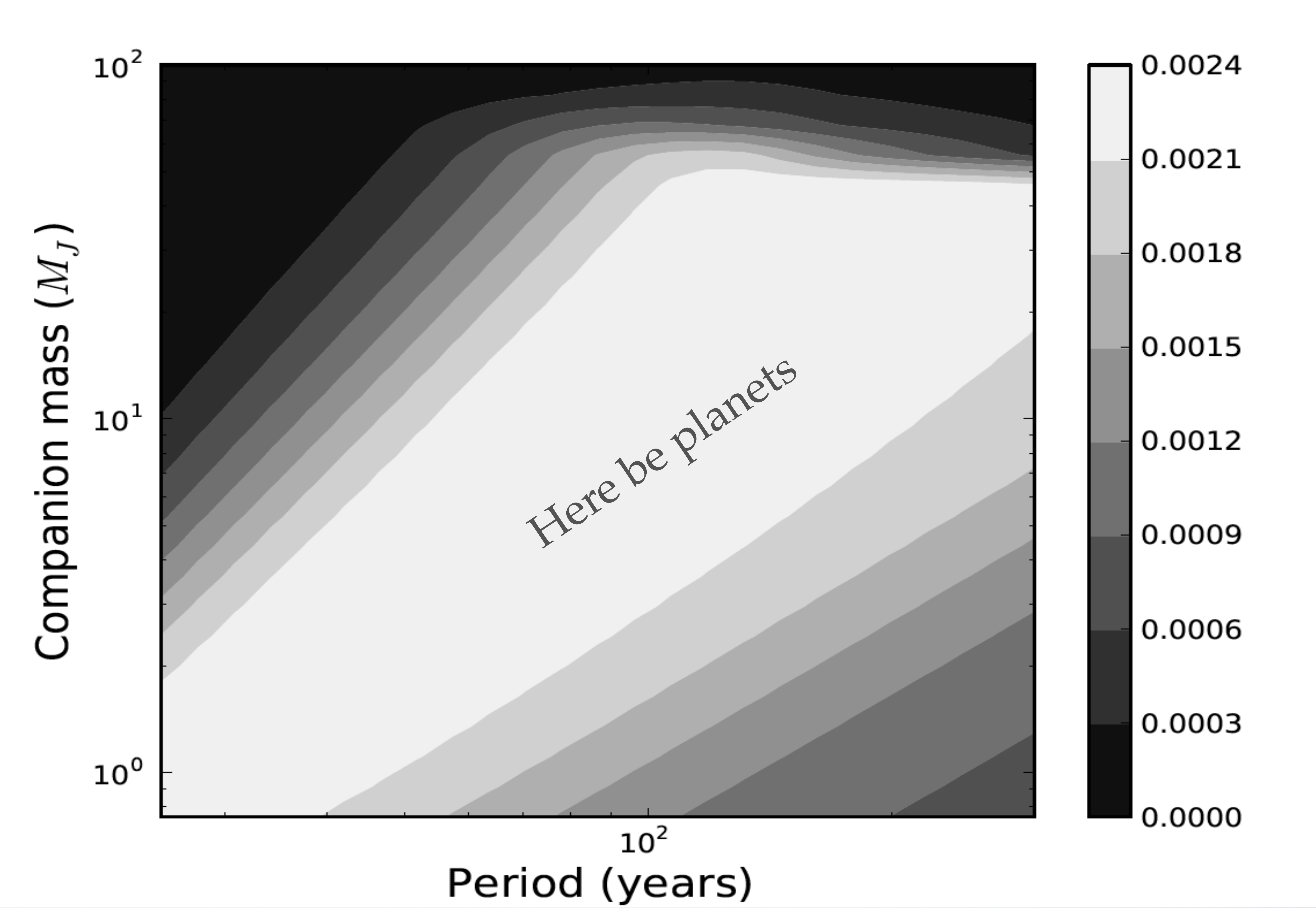

The TRENDS High Contrast Imaging Survey

- PI Justin Crepp (Notre Dame)
- TRENDS:

The TRENDS High Contrast Imaging Survey

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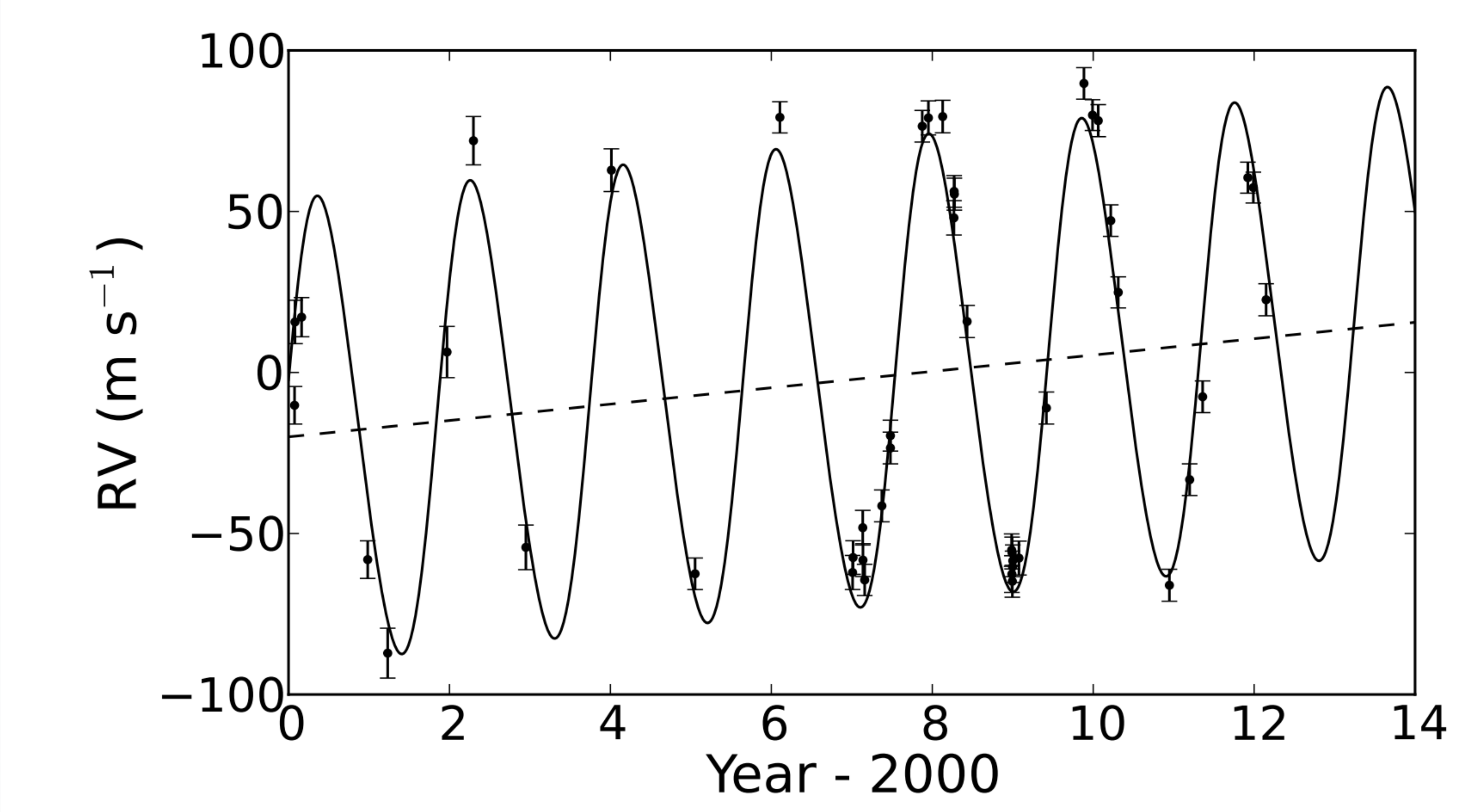
- TRENDS: TaRgeting bENchmark objects with Doppler Spectroscopy

GL 317: An archetypical TREND system



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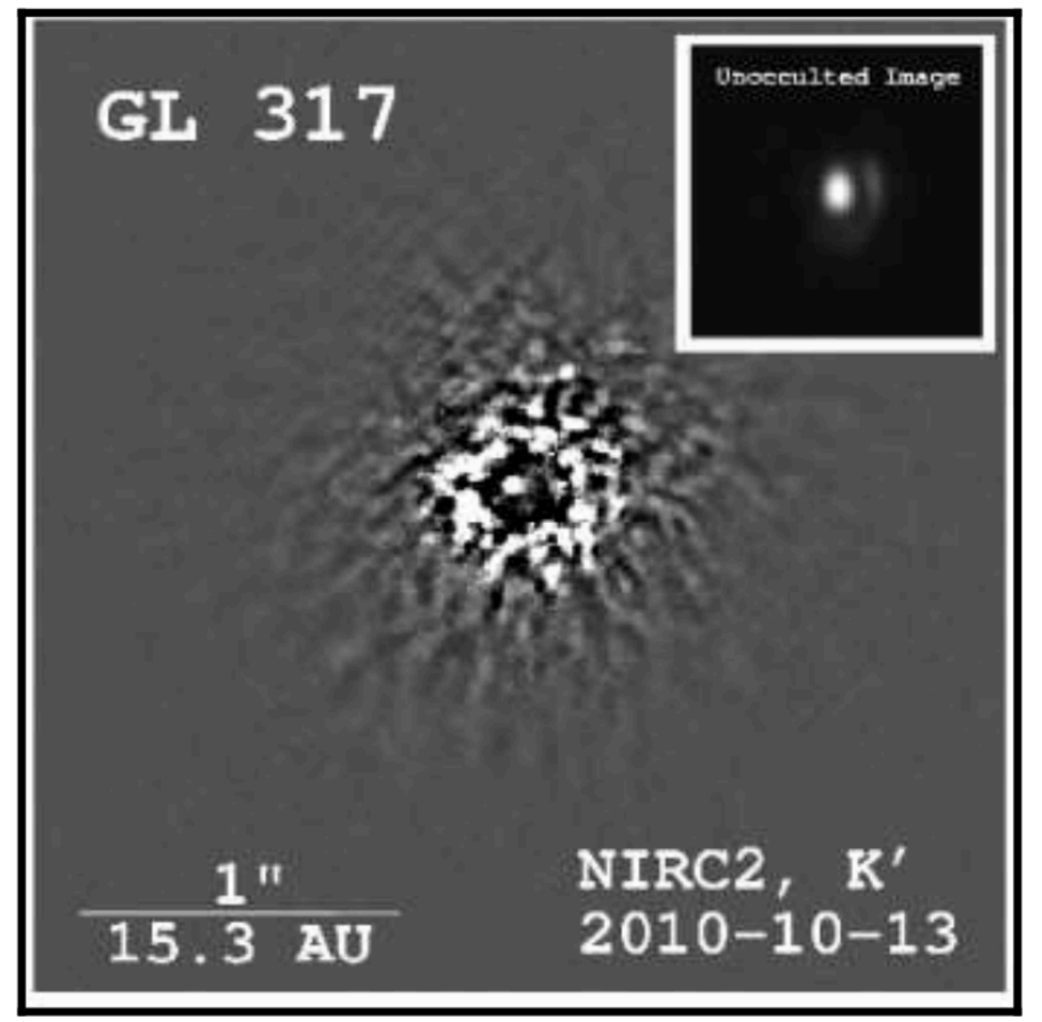

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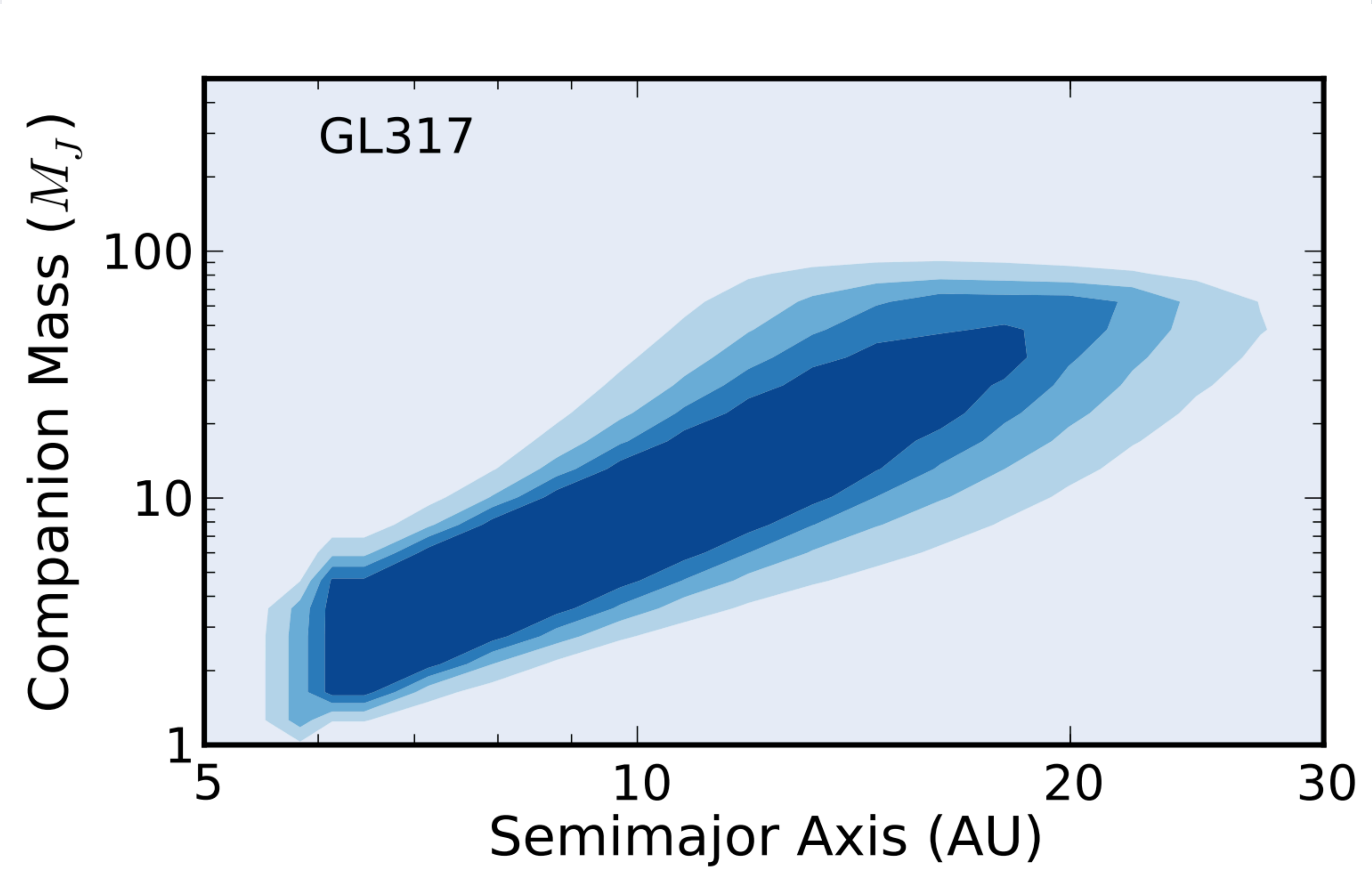
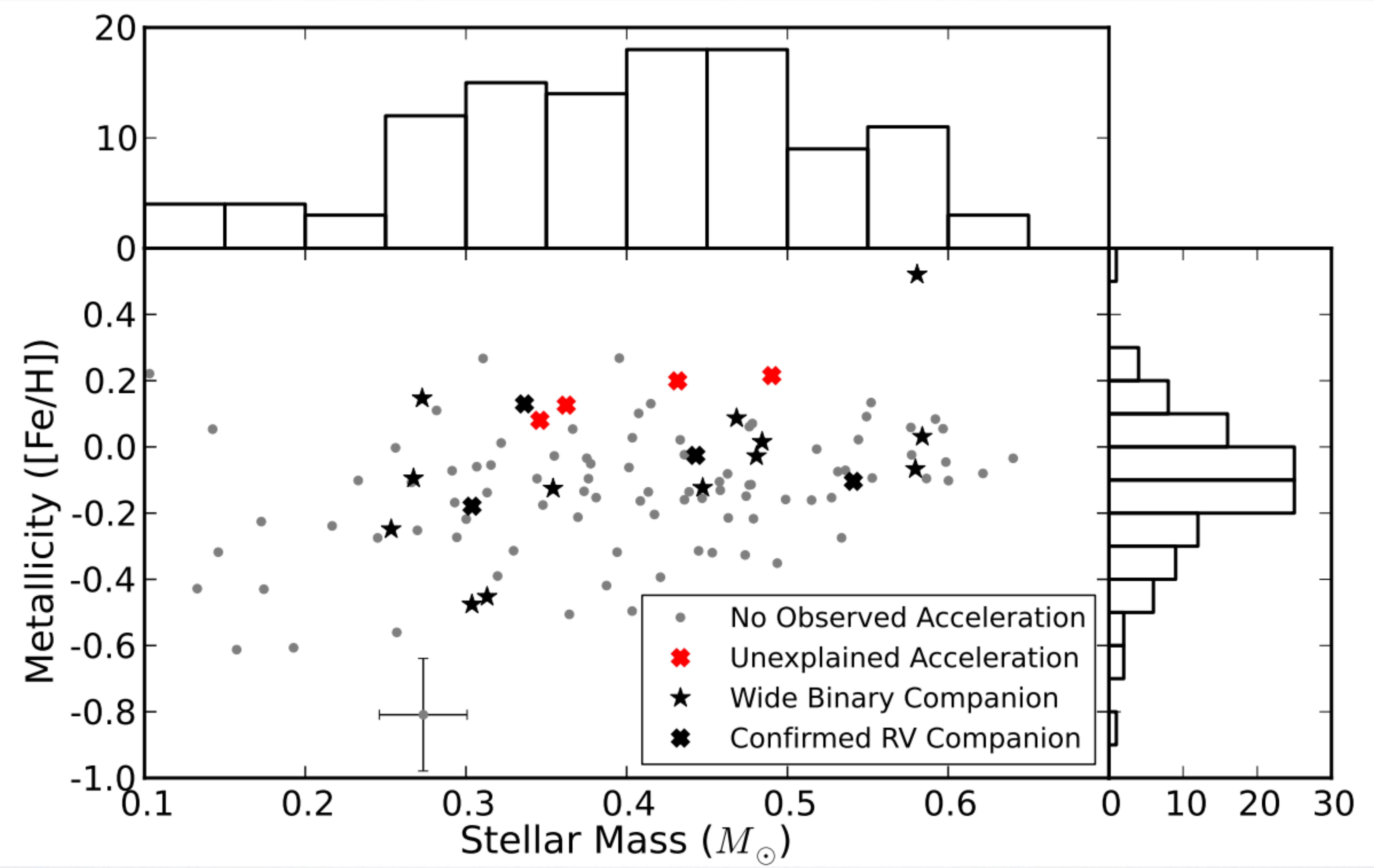


Keck/HIRES data from long-term monitoring exist for more than 100 M dwarfs



Montet et al. 2014

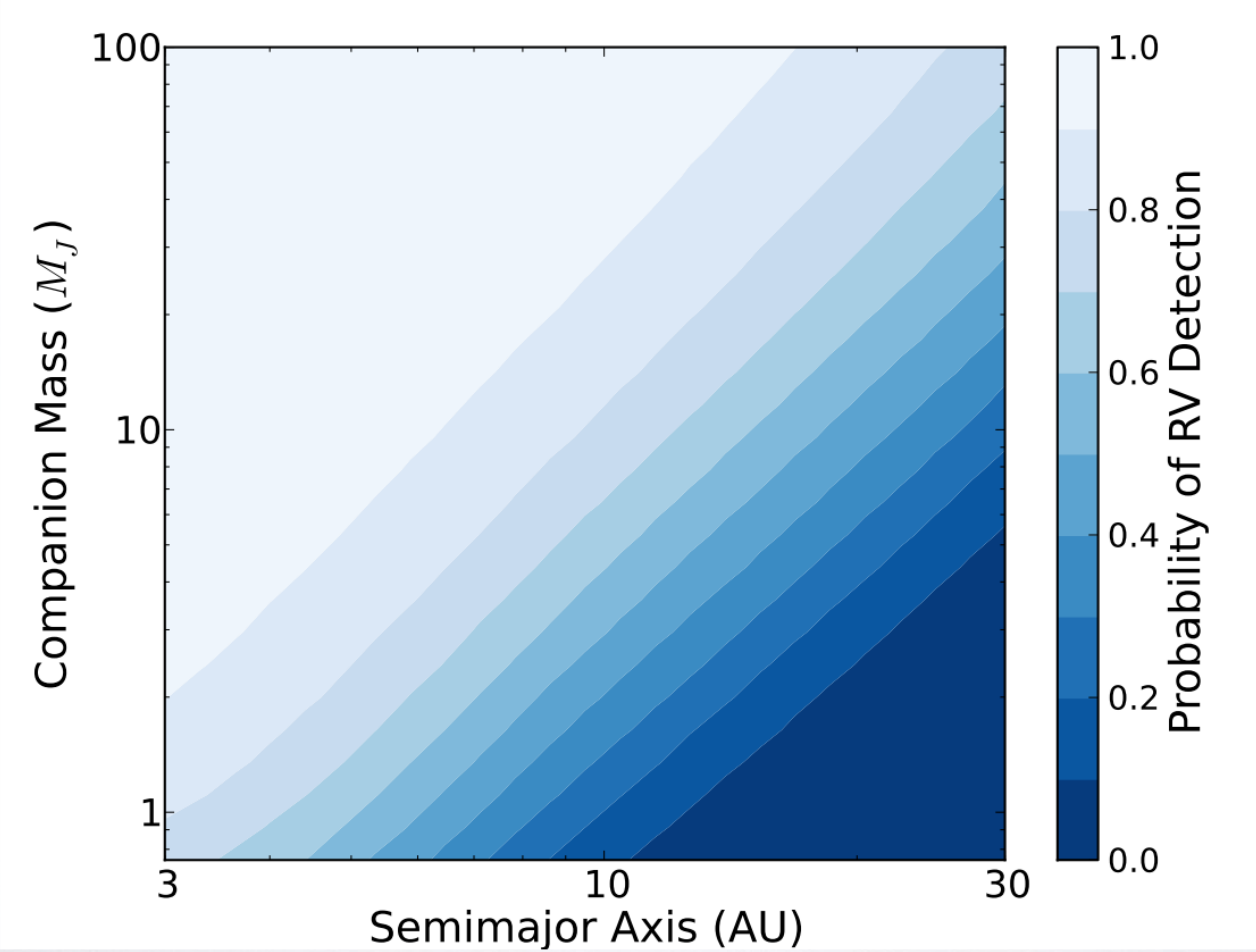
How to measure planet occurrence

$$f_{pl} = \frac{N_{\text{trends}} P(\text{planet}|\text{trend}) + N_{\text{ND}} P(\text{planet}|\text{ND})}{N_{\text{targets}}}$$

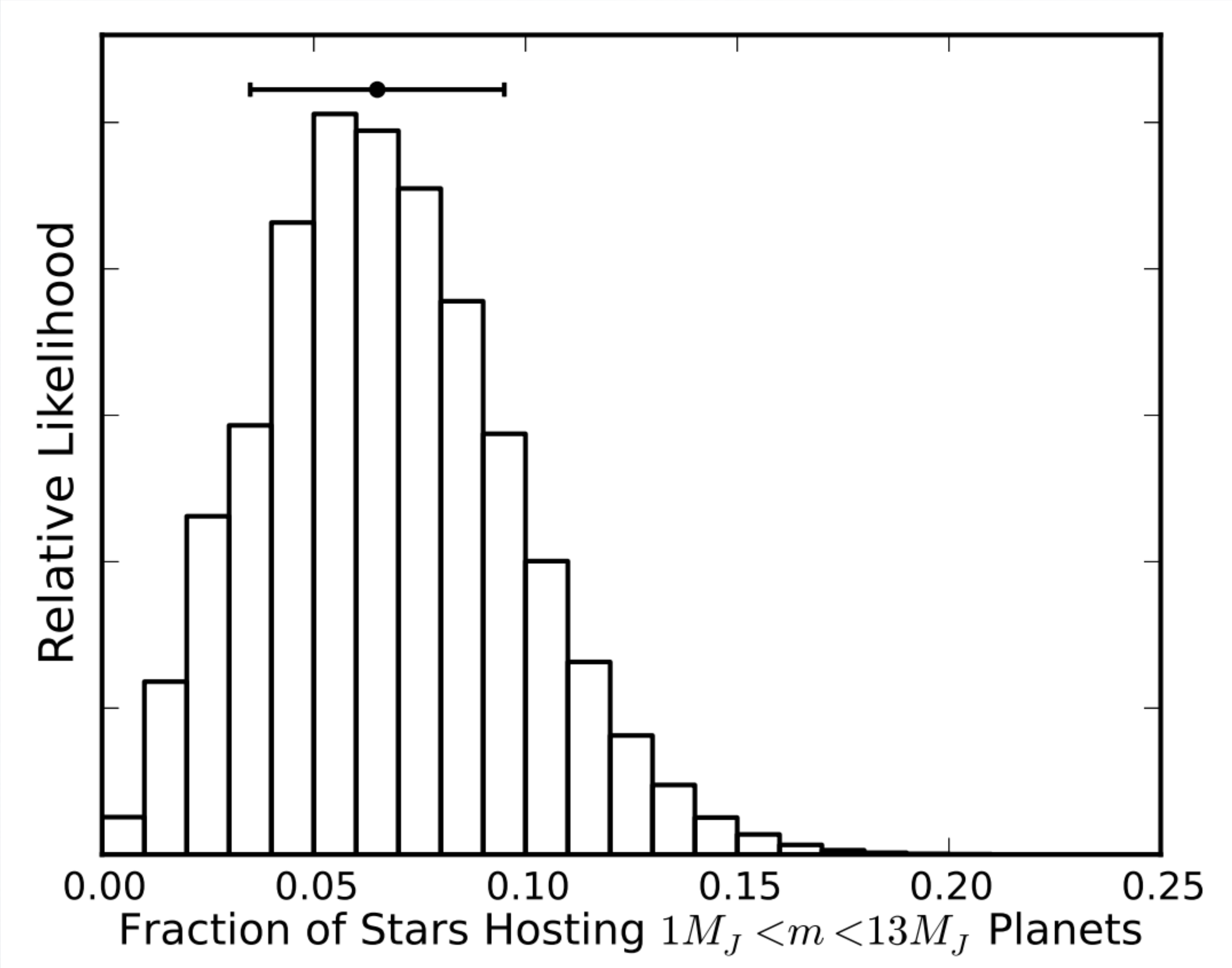
False positives: brown dwarfs, white dwarfs, face-on binaries

False negatives: small planets at wide separation, face-on planets

We can quantify our ability to find a trend

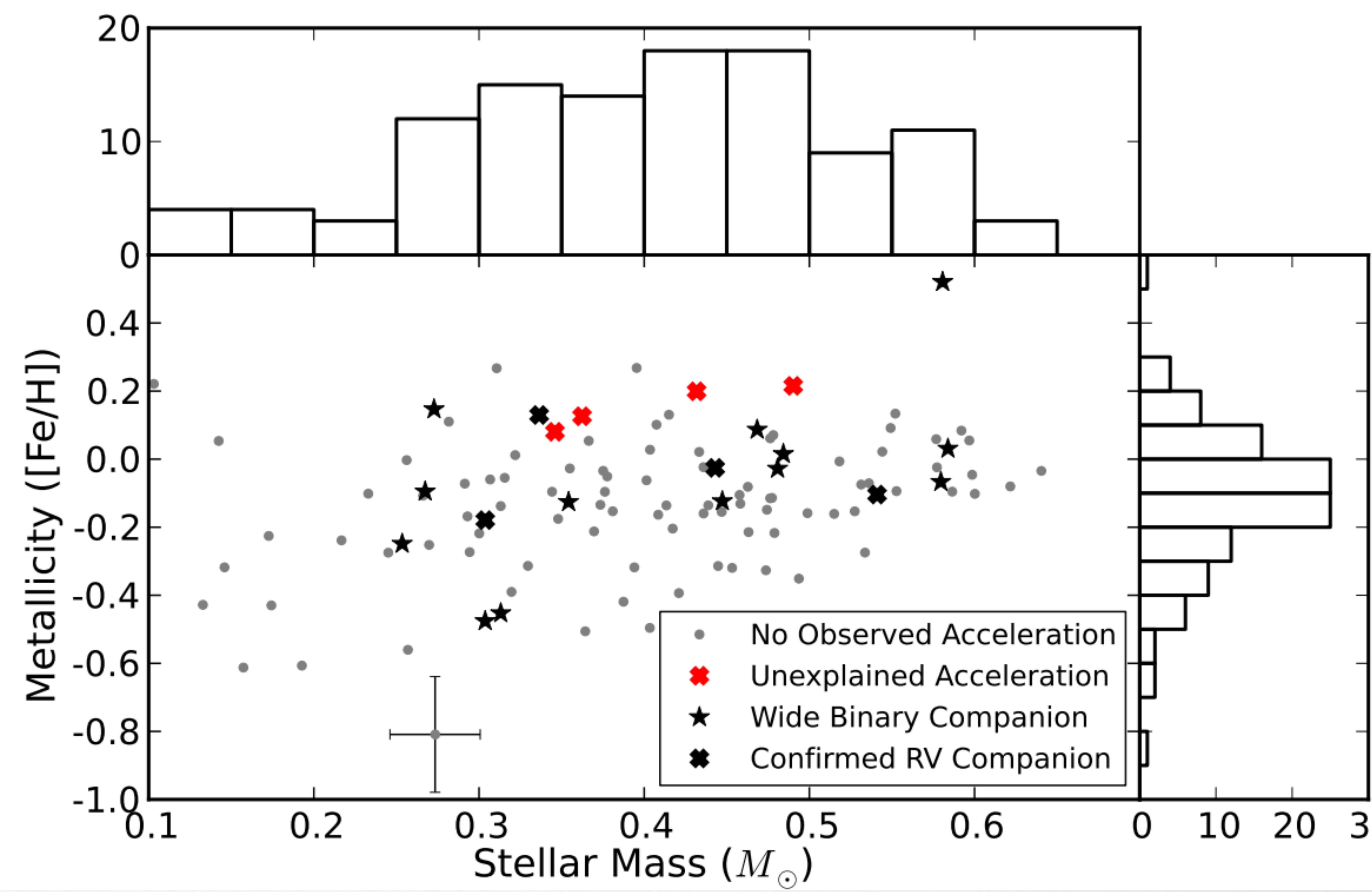


6.5±3.0% of M dwarfs host a Jupiter!



Montet et al. 2014

Occurrence depends strongly on metallicity



Montet et al. 2014

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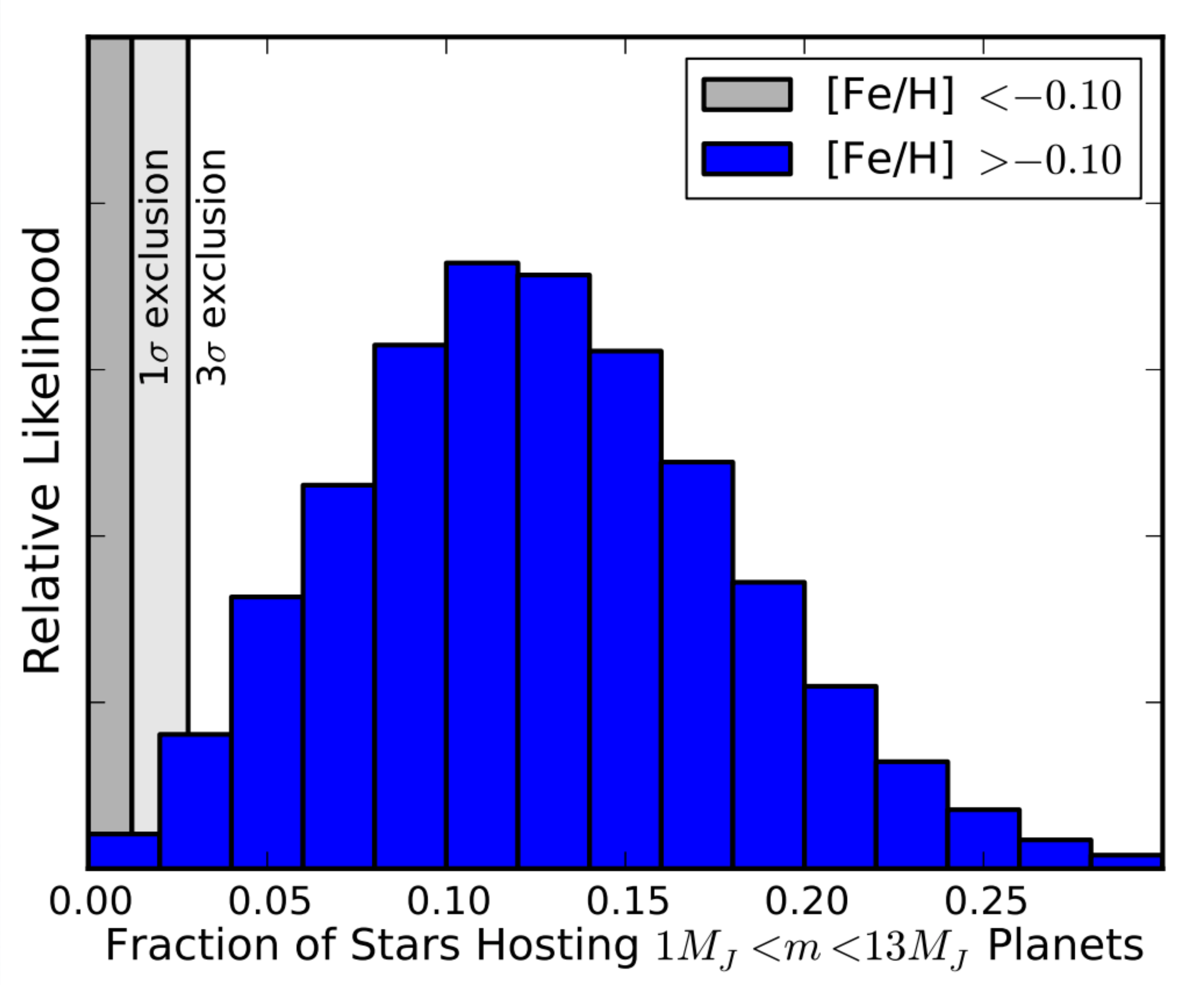
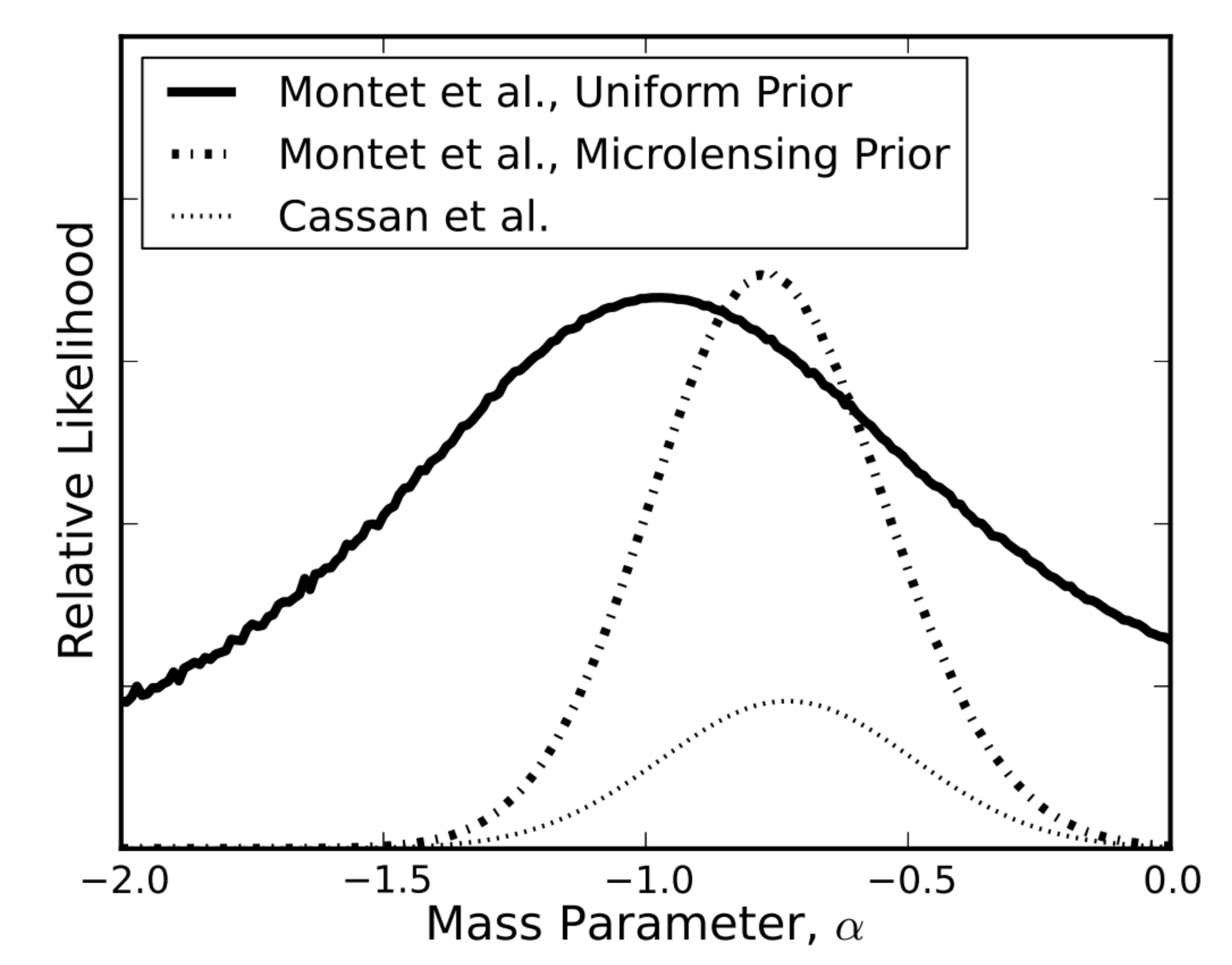


$$f(M,F) = 0.039^{+0.056}_{-0.028} M^{0.8^{+1.1}_{-0.9}} 10^{(3.8\pm1.2)F}$$

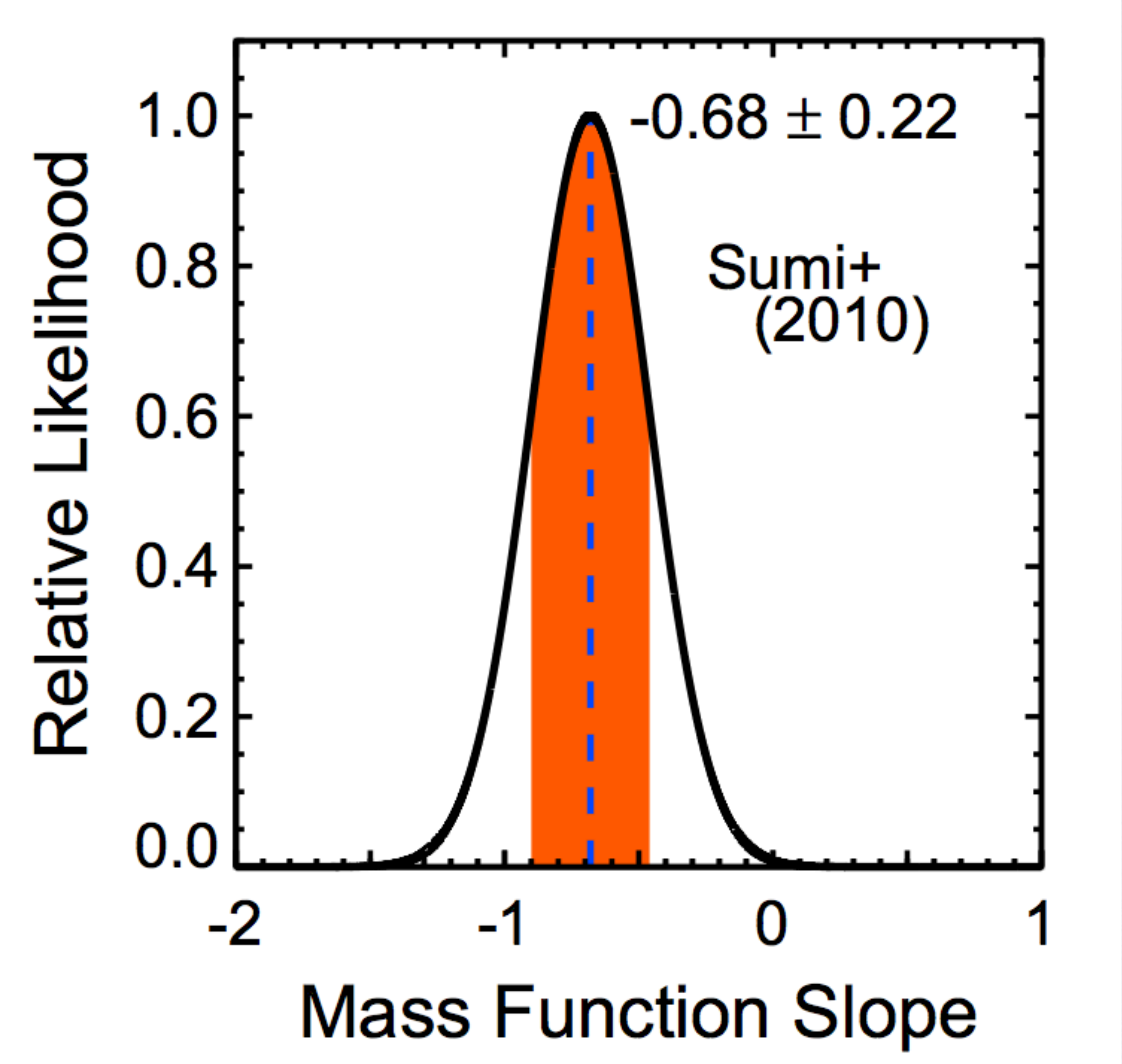
Montet et al. 2014

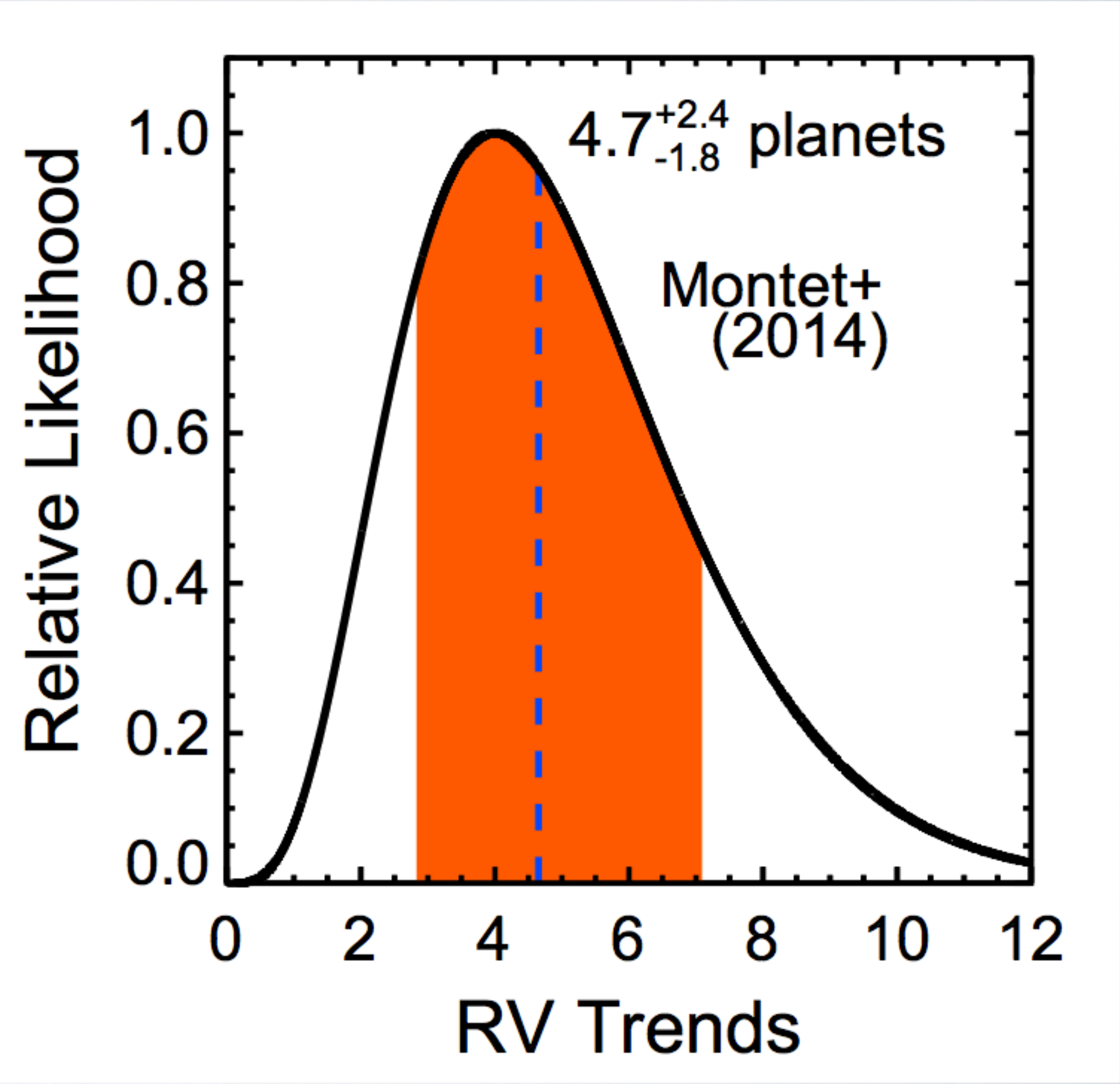
Consistent with microlensing, if steep mass function!



Clanton & Gaudi (2014) find similar results by focusing on microlensing analysis

Agreement with microlensing results





Clanton & Gaudi (2014)

RVs, imaging, and microlensing paint a consistent picture!

6.5±3.0% of M dwarfs host a jupiter analog, with a very strong dependence on metallicity.

The mass function is steep.

A survey targeting metal-rich M dwarfs (like a microlensing survey toward the galactic bulge) could have a large number of planets to find!