**Introduction / Overview**

The mass function is a fundamental outcome and diagnostic of a population’s formation mechanistic(s). Bottom-up processes such as core accretion (e.g., Pollack+1996, Mordasini+2009) result in a majority of low-mass companions, whereas top-down processes involving gravitational instabilities result in a majority of higher mass companions—typically brown dwarfs and low-mass stars (e.g., Kratter+2010, Forgan+2018). An empirical measurement of the substellar companion mass function will enable the relative contributions of each process to be determined. Furthermore, knowledge of the substellar companion mass function, combined with existing detection limits, will enable estimations of additional (unseen) companions, and better exoplanet yield estimates for future surveys.

**Sample and Methodology**

We compiled all known systems with substellar companions (N=67), recomputed masses and mass detection limits from initial photometric measurements, and assembled these observations into a survival analysis framework (Feigelson+Nelson 1985) to compute the cumulative mass function—the derivative of which gives the relative substellar companion mass function.


The substellar companion mass function (blue points) is rising steeply toward smaller values, in broad agreement at low masses with the core accretion model and distribution of RV planets. The flat shape of the distribution beyond ~10-20 M_{Jup} indicates the contribution from companions formed via gravitational instabilities (possibly in the disk stage or earlier). This enables a crude estimate of a companion’s likely formation mechanism based on its mass, and enables an assessment of the undetected multi-planet systems. **This paints an optimistic picture for the future of exoplanet imaging, as improvements in capabilities will enabling imaging lower-mass planets that are more numerous than currently imaged super-Jupiters.**

The mass function’s behavior of rising toward low-masses, combined with existing detection limits, suggests that many systems with at least one known planet could actually be part of a multi-planet system. In line with these predictions, both PDS 70 and Beta Pictoris have since been confirmed as multi-planet systems (Haffert+2019, Lagrange+2019).