Good Things Come in Pairs:
The Companion Frequency and Orbital Distribution of M-Dwarf Binaries

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Motivation and Goals

- M-Dwarf multiplicity is not well constrained
- We seek to **fit a model** to the surface density distribution of M-Dwarfs using point estimates from surveys
- **Calculate a constrained frequency**
  - Specific ranges of mass ratio (q) and semi-major axis (a)
  - Assume companion mass ratio distribution does not depend on orbital separation
  - Expand this to calculate a **total multiplicity fraction**
- Compare to other stellar multiplicity estimates

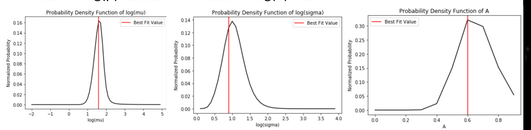
Methods

- Used chi-squared method to **fit a log-normal model** to the surface density

$\chi^2_{red.}$**(3 d.o.f.): 2.137**
$P(X \geq \chi^2_{red.}) = 0.09322$

Despite this low probability, we do not reject the null hypothesis that the data came from this model

Best fit log(μ): 1.582 | Best fit log(σ): 0.946 | Best fit amplitude (A): 0.629

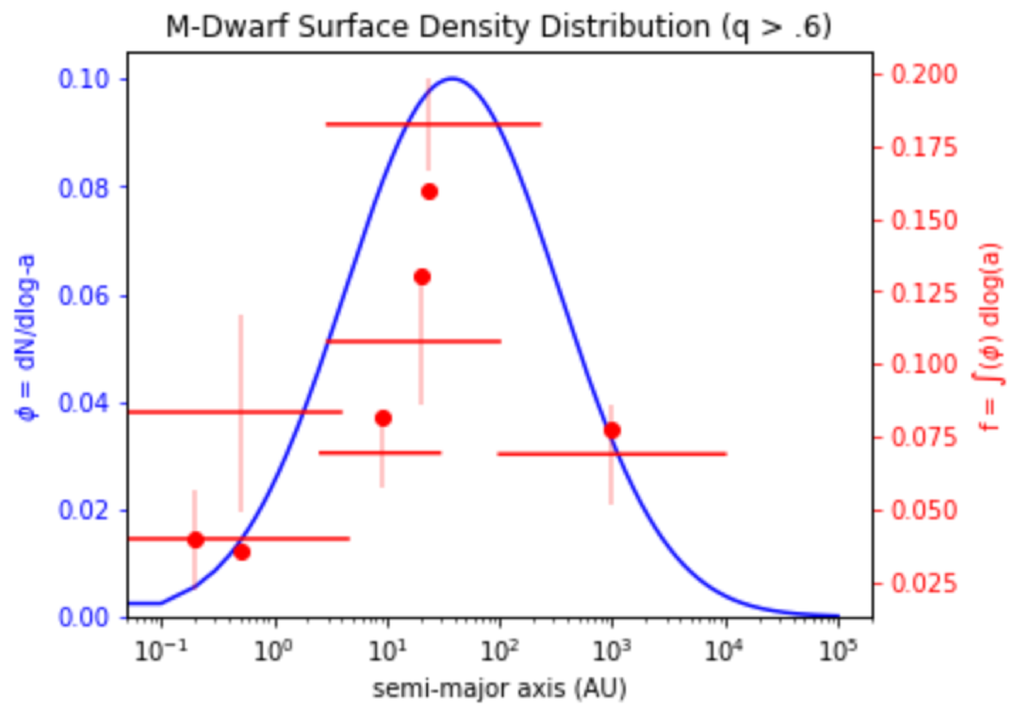


- **Calculate Frequency**

$$f = \int_{q_{min}}^{1} q^{-25}\, dq \; * \int_{a_{min}}^{a_{max}} \mathrm{A} * \phi(\log_{10}(a), \mu, \sigma)\; dlog_{10}(a)$$

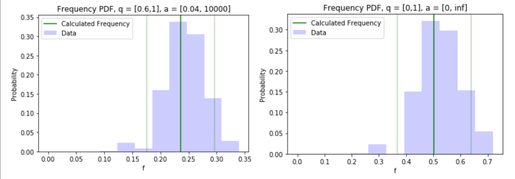
Results

- **Constrained Frequency** (0.6 < q < 1.0, 0.04 < a < 10,000 AU)**: 0.236 +/- 0.061**
- **Total Frequency** (0.0 < q < 1.0, 0.0 < a < ∞ AU)**: 0.503 +/- 0.136**



Distributions of Frequency

- Probability Distribution Functions (PDF's) shows full distribution of possible f values
- Error estimated as 90% confidence interval of PDF's



Conclusions

- **About half of all M-Dwarfs have low mass companions,** many of which are brown dwarfs
- Comparisons
  - Extrapolated results from other surveys over constrained ranges of q and a

Survey	Type FGK Stars – Raghavan et. al. 2010	Type A Stars – De Rosa et. al. 2013
Multiplicity Fraction q = [0.6, 1], a = [0.04, 10000 AU]	f = 0.230 +/- 0.032	f = 0.238 +/- 0.026

- Overall, **multiplicity fraction does not vary significantly across spectral types** over q = [0.6, 1] and a = [0.04, 10000 AU]

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