How Many Small Stars Have Friends?
Companion Frequency and Mass Distribution of M-Dwarfs

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Introduction

- Multiplicity fraction for M dwarf stars is not well defined
- Assumed form for companion mass ratio distribution of M dwarfs (Reggiani & Meyer 2013):

$$\frac{dN}{dq} \propto q^{-.25}$$

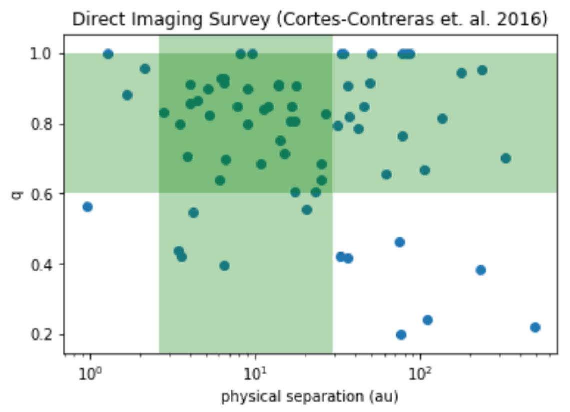
- Assumed form for total stellar multiplicity:

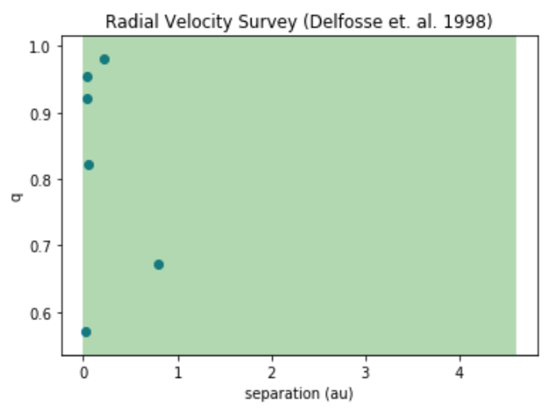
$$f = \int dN = \int_0^\infty \int_0^1 \phi(log(a)) \cdot q^{-\beta}\, dq\, dlog(a)$$

- Assume double integral is separable – q does not depend on a

Survey Data

Data draws from two surveys of M Dwarf binaries that use different detection methods: direct imaging (Cortes-Contreras et. al. 2016) and radial velocity (Delfosse et. al. 1998). Surveys are representative over different ranges of separation, and cut down to q > .6.





References

Cortes-Contreras et. al. 2016, Delfosse et. al. 1998, Reggiani & Meyer 2013, Janson et. al. 2012, Duchene & Kraus Review of Stellar Multiplicity 2013

Abstract

This research explores nature of M-dwarf binaries by comparing the companion frequency derived from two surveys which used different detection methods. This is done over a fixed mass ratio (q > .6) and the ranges of separations (semi-major axis, a) these surveys are complete for. We were able to fit a model to the point estimates of the frequencies and use this to extrapolate a **frequency over all q [0,1] and a[0,∞] of .60**.

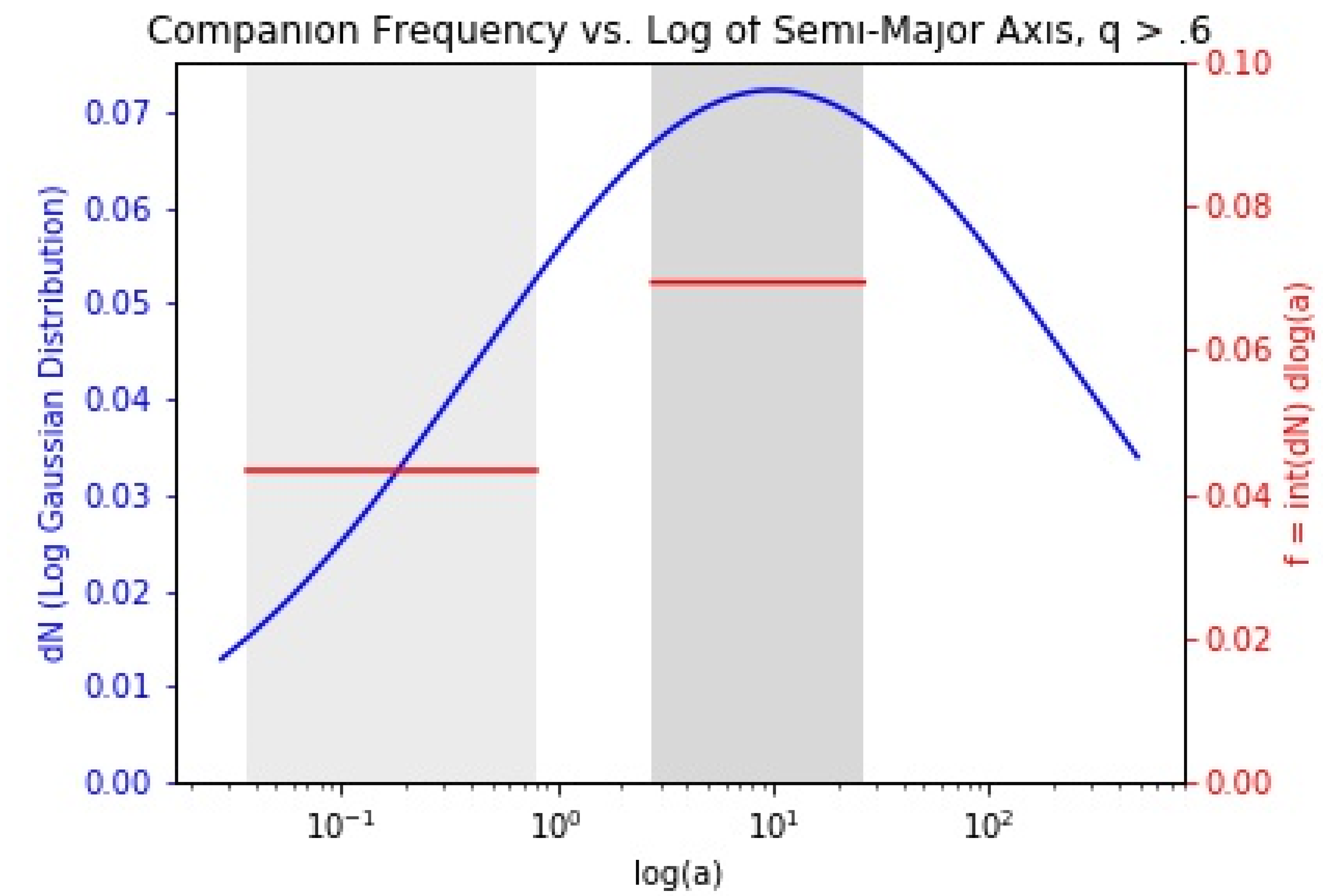
Results

•KS Test - statistical value of .48 and a p value of .19, which allows us to accept the null hypothesis that the two samples (and therefore **a and q) are drawn from the different distributions**

•Analysis – **Log Gaussian distribution fit** over point estimates of frequencies – f(radial velocity) = .043, f(direct imaging) = .069. Using known data points**, found σ (standard deviation) of 1.375, and normalization constant (A) of .249**.

•Multiplicity – **total multiplicity fraction of .60** from integration over all q and a

$$f = \int_0^\infty A \cdot \frac{e^{\frac{(log(a)-\overline{log(a)})^2}{2\sigma^2}}}{\sqrt{2\pi\sigma^2}} dx \cdot \frac{\int_0^1 q^{-.25} dq}{\int_{.6}^1 q^{-.25} dq}$$



Conclusions

- KS test suggests a and q are independent
- Comparison of σ
  - Duchene & Kraus suggest σ ~ 1.3
  - We found σ ~ 1.375
- Comparison of $\bar{a}$
  - Duchene & Kraus suggest $\bar{a}$ ~ 5.3 AU
  - We used $\bar{a}$ of 10 AU
- Comparison of multiplicity fraction
  - Janson et. al. suggests 27%
  - We found 60%

Next Steps

1. Refine process with more data
   1. Find microlensing and astrometry surveys with well-defined completion in q and a
   2. Fit new variables to log-normal model
   3. Recalculate total multiplicity fraction
2. Compare to multiplicity fraction of FGK stars as defined in other work
3. Search for further evidence that a does not depend on q

Further information

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sites.lsa.umich.edu/feps/