Astronomy in Focus, Volume 1, Focus Meeting 8
XXIXth IAU General Assembly, August 2015
Piero Benvenuti, ed.

doi:10.1017/S1743921316002891

Planet Frequency beyond the Snow Line from MOA-II Microlensing Survey

Daisuke Suzuki[1] **, David P. Bennett**[1] **and the MOA collaboration**

[1]Department of Physics, University of Notre Dame, Notre Dame, IN 46556, USA
email: `dsuzuki@nd.edu`

Abstract. We present the first statistical analysis of the exoplanet frequency using planets found by a microlensing survey rather than follow-up observations. We present an analysis of 2007-2012 MOA (Microlensing Observations in Astrophysics) survey data to derive the planet frequency as a function of the planet/star mass ratio, q and separation, s, relative to the Einstein radius. Our sample includes 1472 microlensing events, including 22 planetary events and 1 ambiguous event with possible planetary and stellar binary solutions. The detection efficiency is calculated for each event and we employ a Bayesian analysis to deal with the ambiguous event. A broken power law model is used to fit the mass ratio function and we find a break and likely peak at $q \sim 1.0^{-4}$.

Keywords. gravitational lensing: micro - planetary systems

Detection Efficiency

The exoplanet detection efficiency is calculated for each event following the method of Rhie *et al.*(2000) using a survey data detection threshold of $\Delta\chi^2 \geqslant 100$ between single and binary lens models. Follow-up observations are excluded from these threshold calculations, but are used to help characterize the binary lens signals. The survey sensitivity (the sum of the detection efficiencies for all 1472 events) and the 22-23 planetary events are used to determine the exoplanet mass ratio function as a function of q and s.

Results

We fit a mass ratio function of the form $f = A(q/q_{\rm break})^n s^m$ for $q \geqslant q_{\rm break}$ and $f = A(q/q_{\rm break})^p s^m$ for $q < q_{\rm break}$, where $q_{\rm break}$ is the mass ratio for a break in the mass ratio function, and search for the best fit model with a Markov Chain Monte Carlo. We find that the mass ratio function rises steeply toward lower masses as $n \approx -1$, and then has a rather sharp break at $q_{\rm break} \sim 1.0^{-4}$. Below this, the mass ratio decrease or is flat. A mass ratio function that increases with separation, $m \approx 0.5$, is somewhat favored, but $m = 0$ is only disfavored by 1-σ. The mass ratio function changes only slightly when the previous microlens studies Gould *et al.*(2010) and Cassan *et al.*(2012) are added. Since the typical host star mass is $\sim 0.5M - \odot$, this mass ratio function break corresponds to about a Neptune mass, suggesting that "failed Jupiter" cores are the most common planets beyond the snow line.

References

Gould, A., Dong, S., Gaudi, B. S., *et al.* 2010, *ApJ*, 720, 1073
Cassan, A., Kubas, D., Beaulieu, J.-P., *et al.* 2012, *Nature*, 481, 167
Rhie, S. H., Bennett, D. P., Becker, A. C., *et al.* 2000, *ApJ*, 533, 378