On The Nature Of Sub-stellar Mass Companions To Solar-Like Stars

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The observational distinction between planets and brown dwarf secondaries is unclear. Lacking observations relating directly to formation (*e.g.*, multi-component system structure) the best one can do is to compare the overall properties of these sub-stellar mass companions (SSMC's) to those of the relevant stellar population: stellar-mass secondaries in binary systems (for which a nearly complete and unbiased survey exists). Results of the comparison are striking: all measurable properties (other than mass) of SSMC's to solar-like primaries are statistically indistinguishable from those of stellar-mass secondaries in binary systems of similar primary spectral type (mid-F to mid-K dwarfs). The orbital characteristics of the two populations are essentially identical: in both cases semi-major axes, periods, and angular momenta are distributed approximately as $f(x) \propto x^{-1}$ for $x = a, P, L$; and eccentricities approximately as $f(e) \propto e^{-0.5}$. There is no correlation of eccentricity with other orbital properties, aside from circularization of close orbits in both populations. Secondary masses in both populations are uncorrelated with all orbital properties; the mass spectrum of SSMC's is seamless and shows no statistically significant evidence for bi-modality reflective of a mixture of planets and brown dwarfs. Taken altogether, such comparisons argue for a common formation mechanism for stellar-, and nearly all sub-stellar-, mass secondaries to solar-like stars, including objects of apparently planetary mass. In this sense the recently discovered "extrasolar planets" more resemble brown dwarfs than they do planets.