PROBING BINARY FORMATION THEORIES WITH THE LARGEST CATALOG OF ULTRA-WIDE, LOW-MASS BINARIES

Saurav Dhital[1,2] (sauravdhital@erau.edu), Andrew A. West[2], Keivan G. Stassun[3], Nicholas M. Law[4], Angela P. Massey[2]

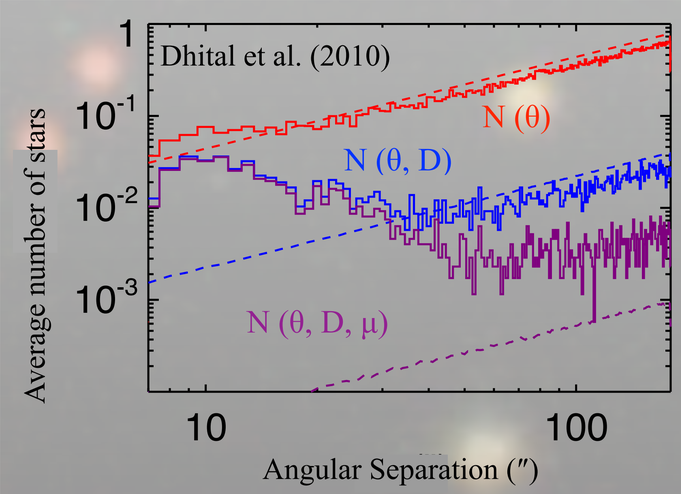
[1] Embry-Riddle Aeronautical Univ., [2] Boston Univ., [3] Vanderbilt Univ., [4] Dunlap Institute, Univ. of Toronto

SLoWPoKES

Sloan Low-mass Wide Pairs of Kinematically Equivalent Stars

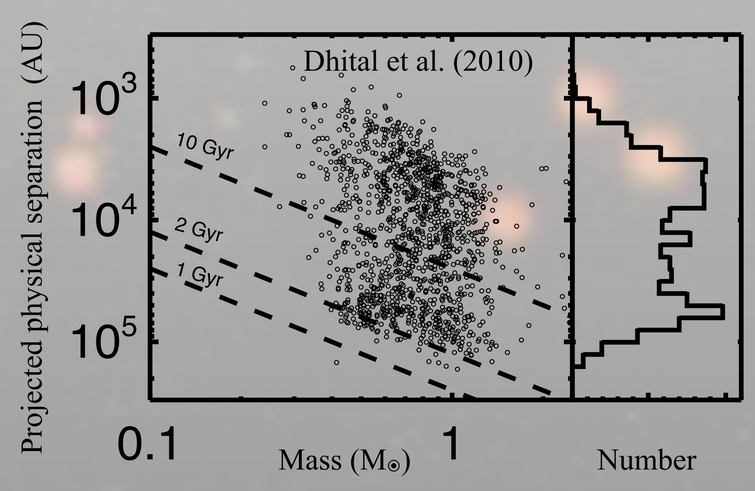
The SLoWPoKES catalog of 1342 wide binaries was identified from the Sloan Digital Sky Survey (York et al. 2000) photometric catalog by matching angular separations, photometric distances, and SDSS/USNO-B proper motions (Dhital et al. 2010). In SLoWPoKES-II, we identified 105,537 binaries without using proper motions. All binaries have a probability of chance alignment ≤ 5%. The projected physical separations are 10^3–10^5 AU wide, making them extremely fragile systems. In addition to the large number of pairs, *SLoWPoKES contains a wide variety of pairs in mass, metallicity, age, evolutionary states, and binary separations.* A collage of SDSS images of the binaries are shown in the background of this poster.

SLoWPoKES–II: Identifying binaries without proper motions



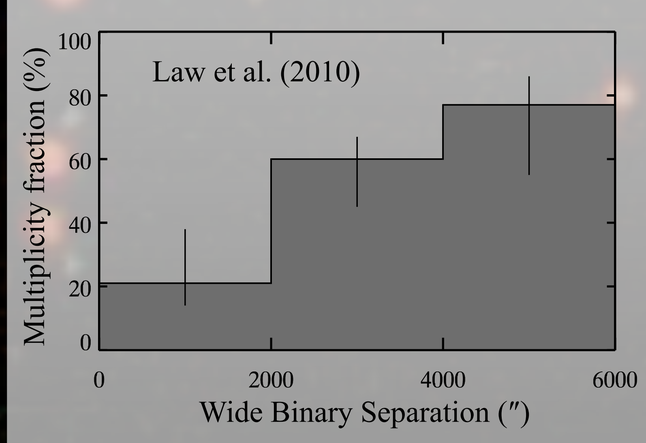
The average number of companions for ≳1600 lines-of-sight in SDSS DR7 are shown as solid lines. The dashed lines show the corresponding simulated distributions that only consist of non-associated, single stars, thus, providing a measure of the likelihood of chance alignment. Two features stand out: (i) the excess of pairs at close separations, which is a signature of binary systems (Michell 1767) and (ii) intriguingly, the blue and purple histograms are almost identical up to 20–25″, suggesting proper motions were not needed to identify those binaries. *We have exploited this to identify 105,537 wide binaries with probability of chance alignment of ≤ 5%.*

Multiple populations of wide binaries: Sculpted by dynamical evolution?



The distribution of the SLoWPoKES binaries shows two different populations, with a break at ~20,000 AU. When compared with binary dissipation timescales (dashed lines; Weinberg et al. 1987), they can be interpreted as (i) tightly bound "wide" systems that are expected to last 10 Gyr or longer; and (ii) weakly bound "ultra-wide" systems that are expected to dissipate within a few Gyr. *The young, extremely fragile ultra-wide binaries would be destroyed via interactions with the Galactic tide, giant molecular clouds, and other stars as they traverse the Milky Way* (Weinberg et al. 1987; Jiang & Tremaine 2010).

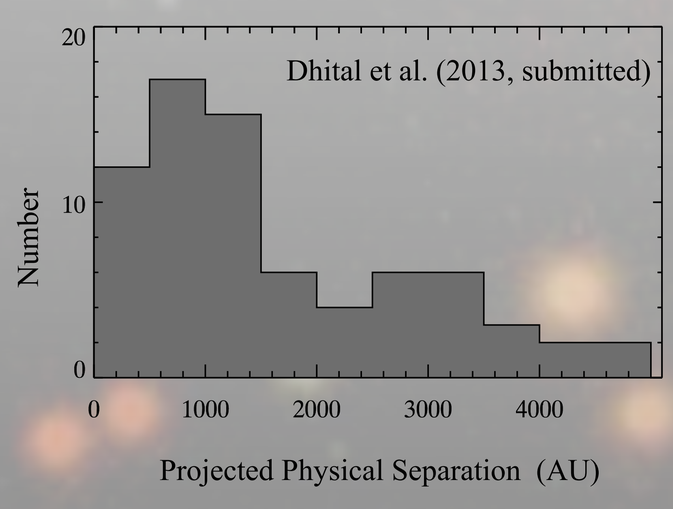
Increasing hierarchical multiplicity: Different formation or evolution?



In a LGS–AO followup study at Keck/Palomar, we found that the frequency of companions was higher for wide binaries as compared to single stars (Fischer & Marcy 1992; Henry & McCarthy 1993). Moreover, *the hierarchical multiplicity increases as a function of wide binary separation, from 20% at 1000 AU to 80% at 5000 AU, with a 2σ significance.* This suggests that either binary formation unfolds differently at different separations or at the largest separations doubles are preferentially destroyed leaving only triples/quadruples.

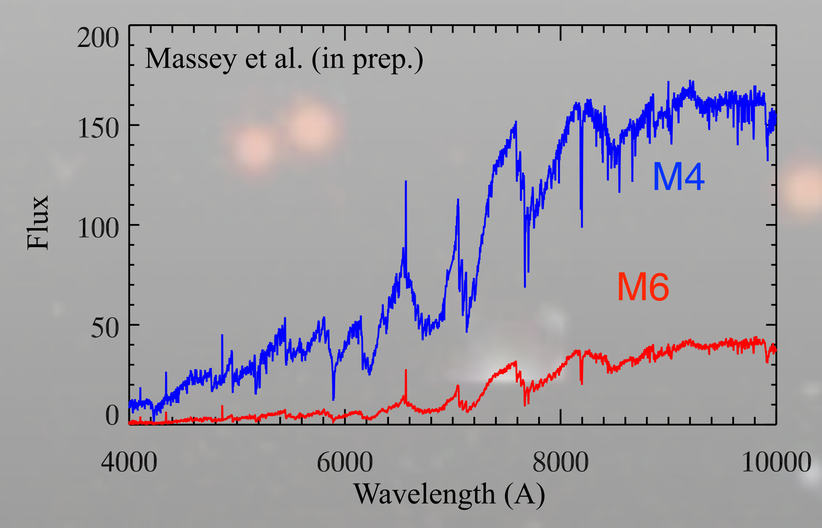
We are conducting a larger survey with binaries at smaller masses and larger separations at Gemini-N.

Wide binaries at the end of main sequence suggests universal formation mechanism at all masses



SLoWPoKES-II has 74 wide (>100 AU) pairs with estimated spectral types later than M7. Currently, only 13 wide, VLM systems are known. While spectroscopic confirmation is required (and ongoing), these systems are too fragile to have formed via ejection (Reipurth & Clarke 2000). *The continued presence of wide binaries to the end of the main sequence suggests the formation mechanism might be universal across all masses* (e.g., Hennebelle 2011; Jumper & Fisher 2012).

SDSS-III BOSS: Getting the age of wide binaries via magnetic activity



Age is a key parameter in understanding whether the observed wide binary distributions are shaped during formation or by dynamical interactions. *With Hα-activity based age estimates (West et al. 2008, 2011), we will determine whether the ultra-wide binaries are indeed young, as well as better characterize the observed binaries.* We have been awarded 2000 fibers by the SDSS-III BOSS survey (Dawson et al. 2013). BOSS is expected to be completed in early 2014.