

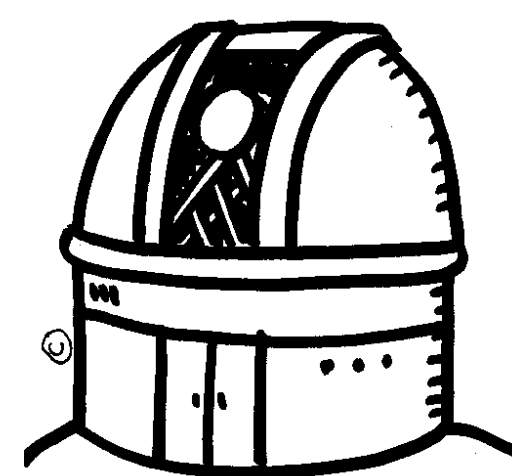
Do stellar companions influence hot Jupiter formation & migration?

Formation

Migration

Friends of hot Jupiters

A direct imaging survey for stellar companions to hot Jupiter systems



Keck
NIRC2



77 FGK
stars



4 year
baseline

Henry Ngo (Caltech), with H. Knutson, S. Hinkley, M. Bryan, J. Crepp, K. Batygin, I. Crossfield, B. Hansen, A. Howard, J. Johnson, D. Mawet, T. Morton, P. Muirhead, & J. Wang

Hot Jupiter host stars have **fewer stellar companions** at separations of **1-50 AU**, but **three times more stellar companions ($47\% \pm 7\%$)** at separations of **50-2000 AU** compared to solar-type field stars*. **Raghavan et al. (2010)*

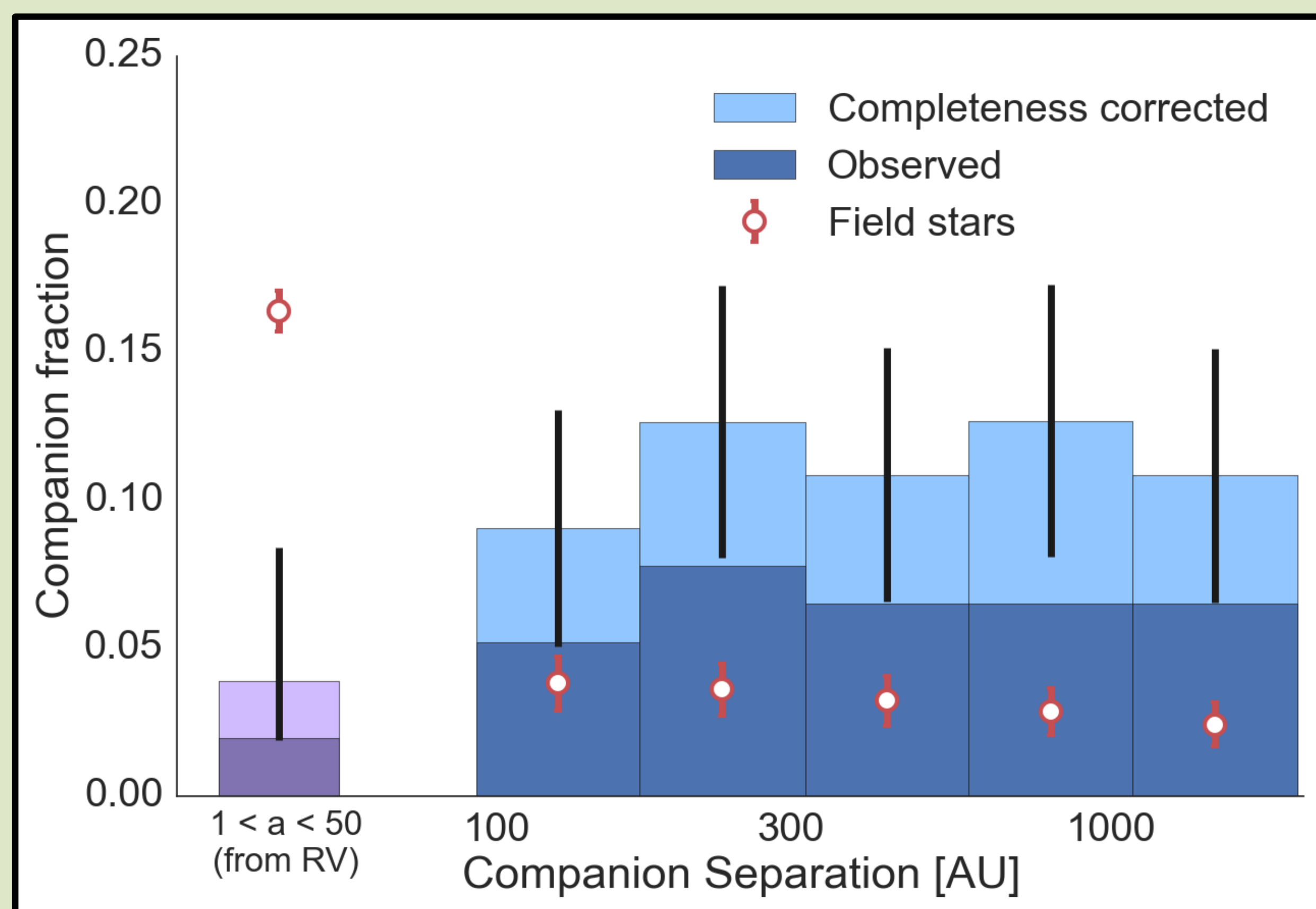


Figure from Ngo et al. 2016 (ApJ, accepted, arXiv: 1606.07102)

Stellar companions to hot Jupiter host stars have a **mass ratio distribution that peaks at smaller values**. This is different from field star binaries*, which tend to be uniformly distributed across all mass ratios. **Raghavan et al. (2010)*

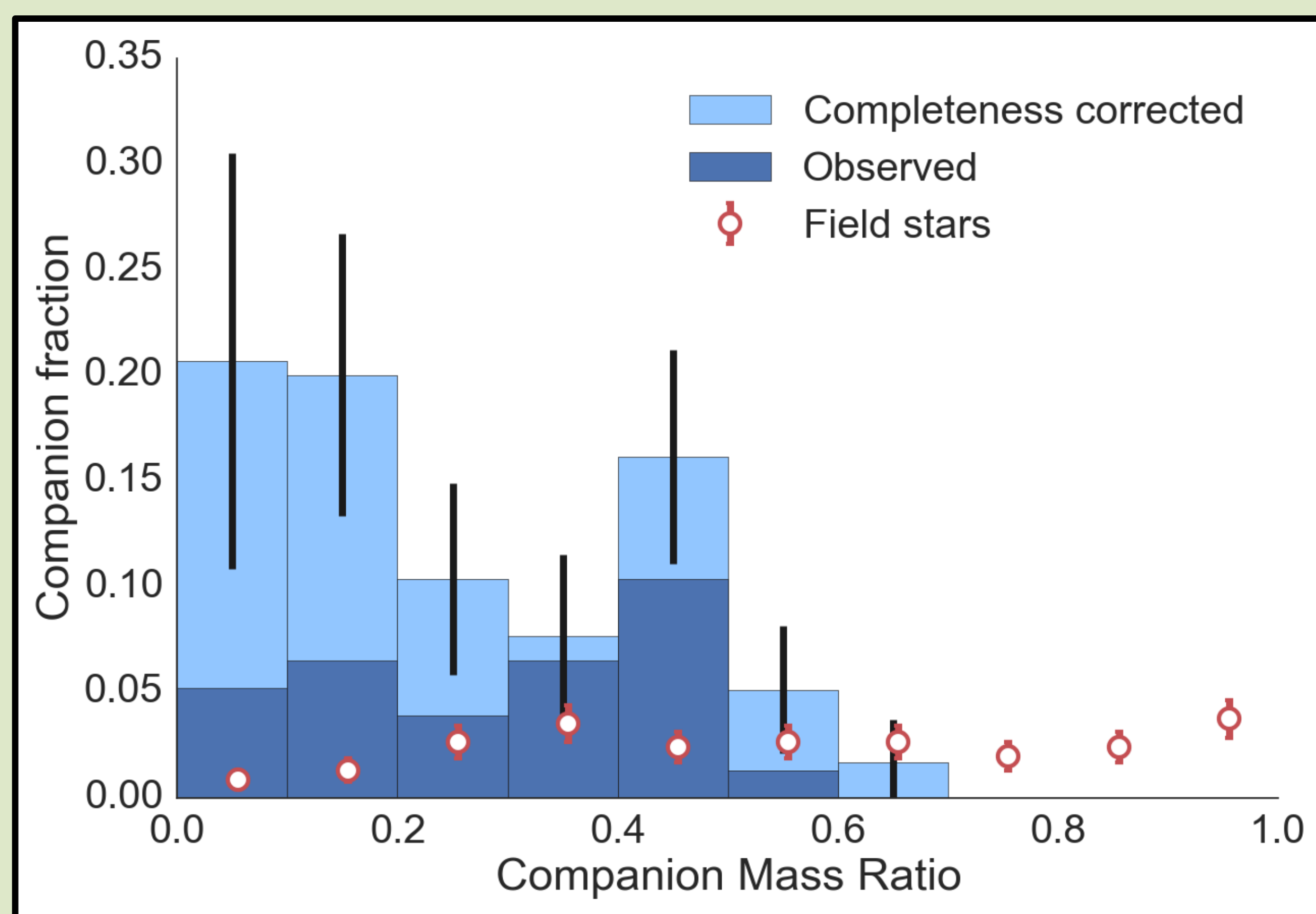
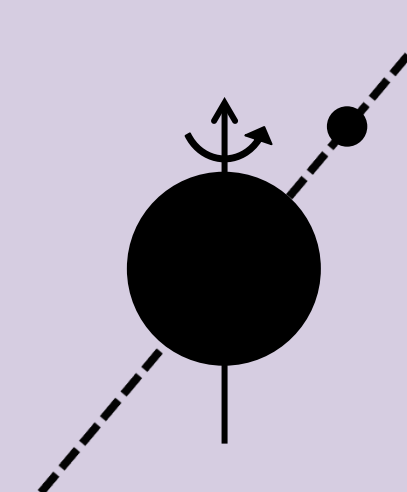


Figure from Ngo et al. 2016 (ApJ, accepted, arXiv: 1606.07102)

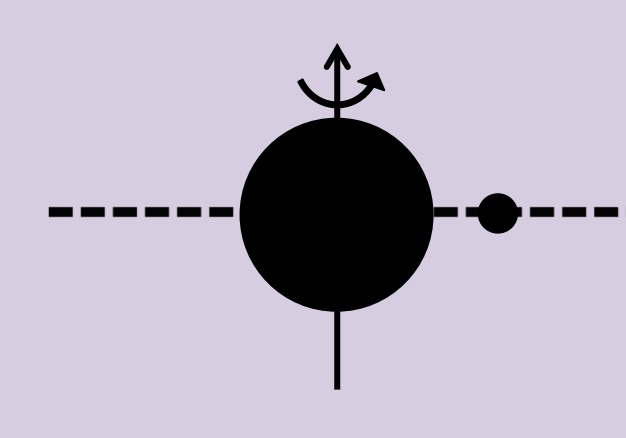
Wide binaries systems may be favourable for giant planet formation

No correlation found between misaligned hot Jupiters and presence of a stellar companion. *(Ngo et al. 2015, ApJ, 800:138)*

Misaligned
companion fraction
 $48\% \pm 12\%$



Well-aligned
companion fraction
 $51\% \pm 13\%$



Below, the distribution of stellar companion mass ratio vs. separation. Lines are the minimum companion mass required to drive Kozai-Lidov oscillations*. Accounting for a distribution of initial planet semi-major axes and eccentricity, we find that **less than 20% of hot Jupiters could have experienced Kozai-Lidov migration**.

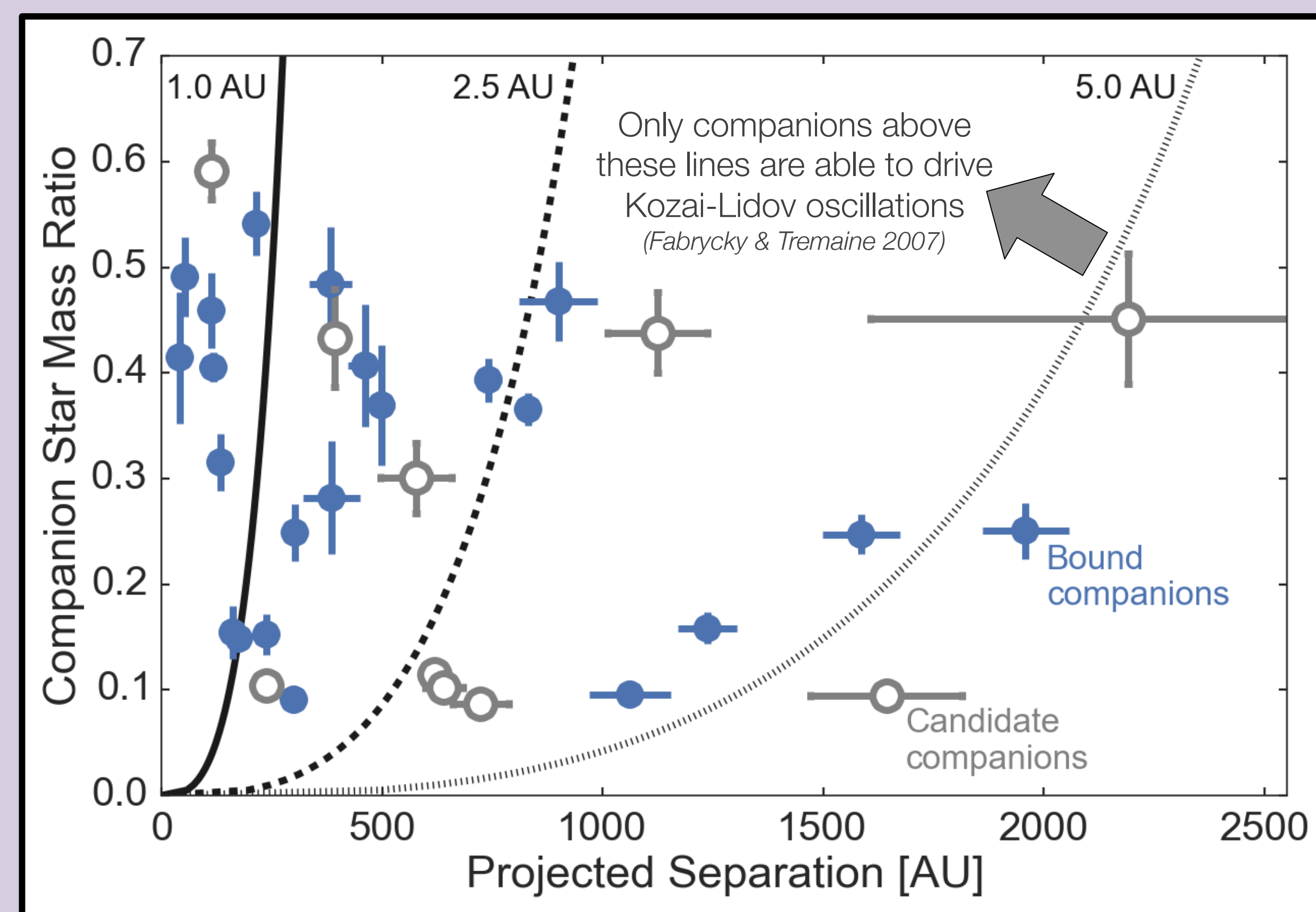
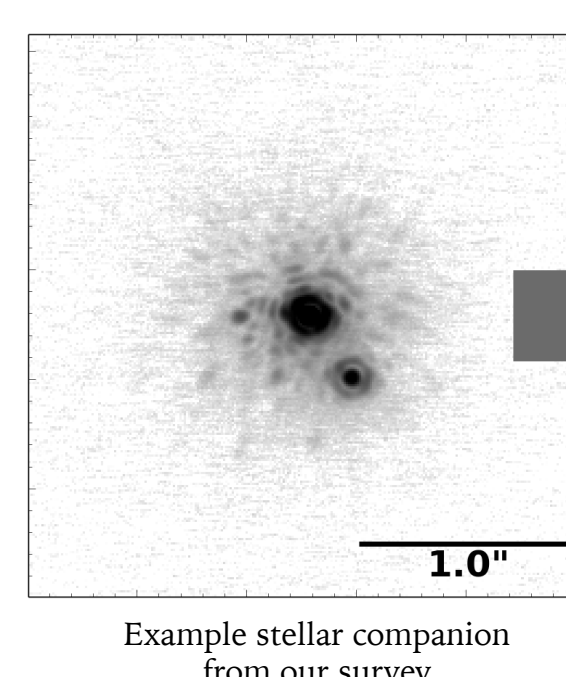


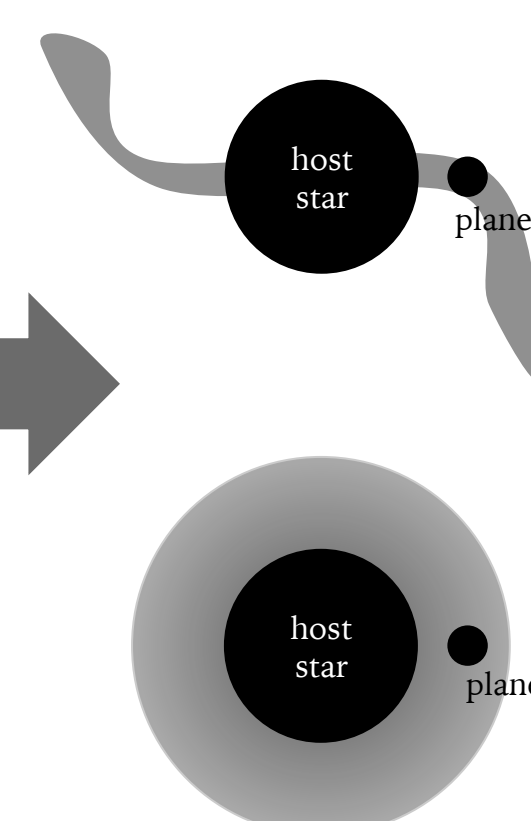
Figure from Ngo et al. 2016 (ApJ, accepted, arXiv: 1606.07102)

Stellar Kozai-Lidov migration not responsible for most hot Jupiters

Enhancing giant planet formation with wide binaries



Example stellar companion from our survey



binary star creates
buildup of material
in host star disk

or

host star disks in
binary systems are
more massive



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