Transiting hot Jupiters in binary star systems

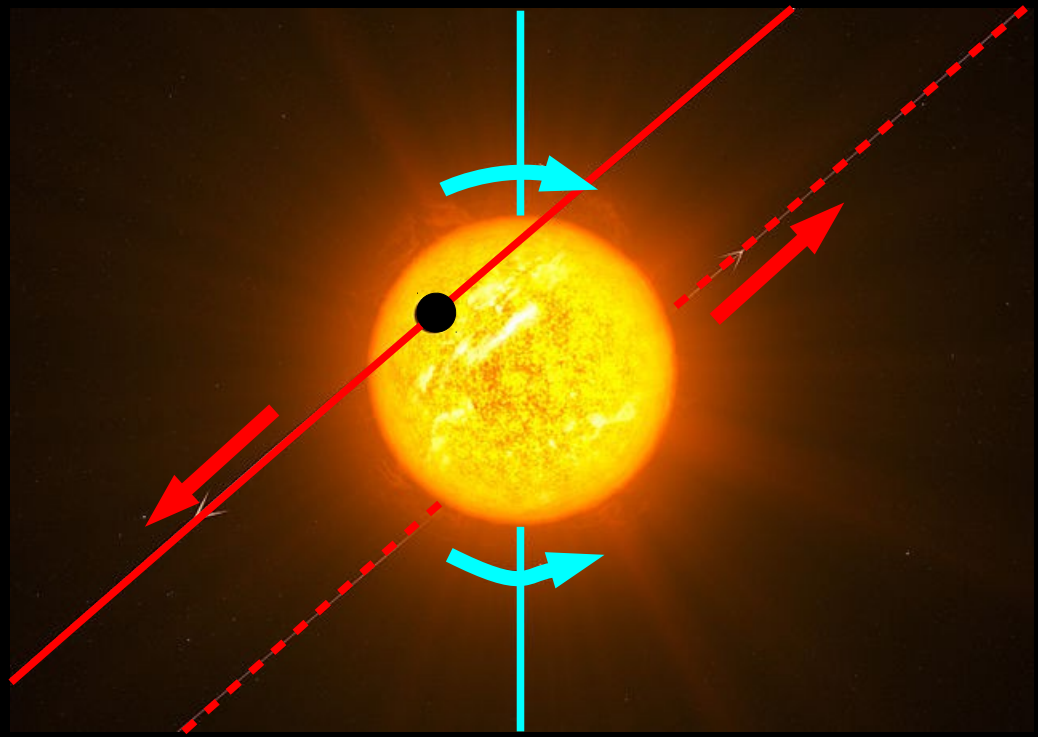
Daniel Evans
Keele University, UK

Collaborators: J. Southworth, B.Smalley
S. Hinkley (Exeter), J. Girard (ESO)
MiNDSTeP Consortium

ESO/L. Calçada

Hot Jupiters

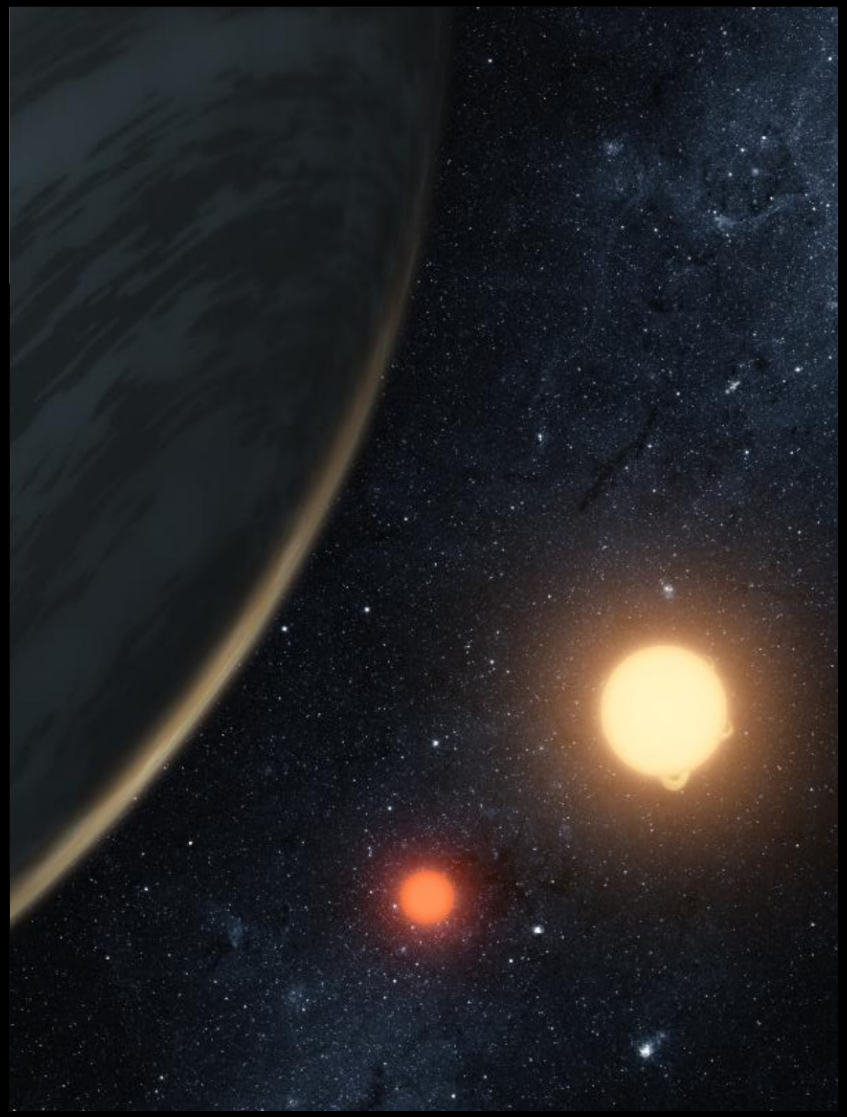
- Giant planets with periods <10d
- Many formation mechanisms proposed
- E.g. in-situ formation, disc migration, planet-planet interactions, distant stellar companions.
- Many have misaligned orbital axes, evidence of high inclination migration?



ESO/L. Calçada

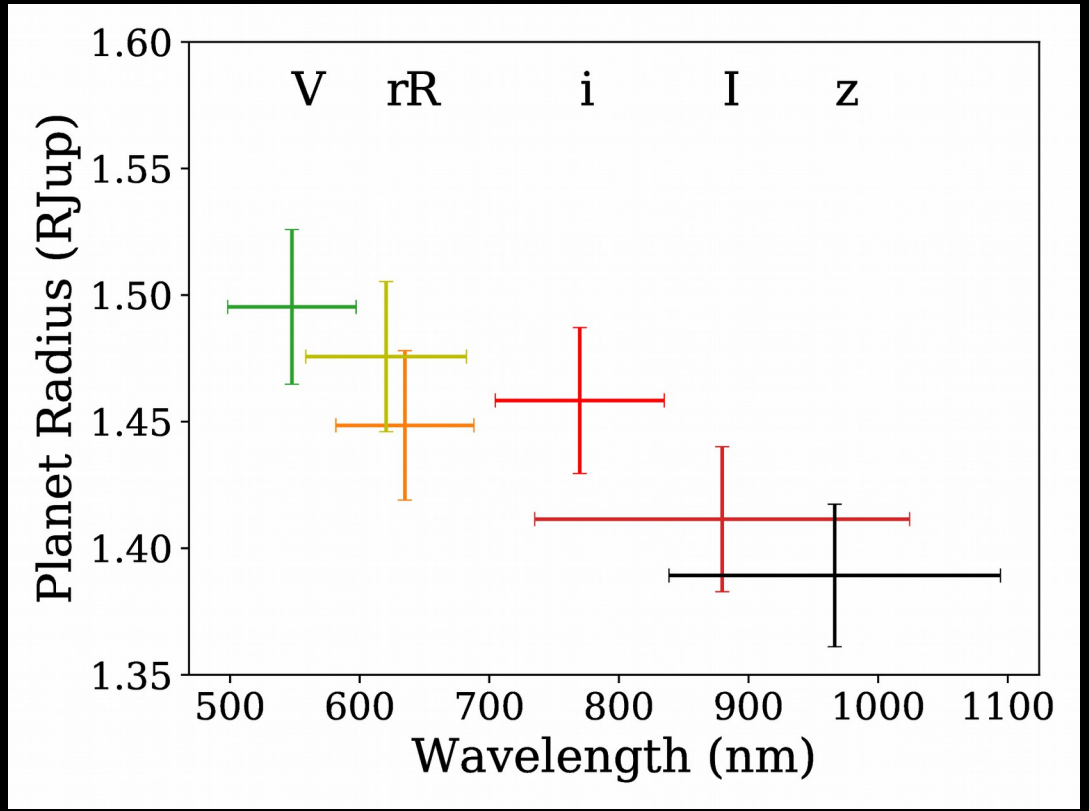
Binary questions

- Does the population of HJ host stars resemble that of field stars?
- How do the binary ratio and properties of binary companions compare?
- Do “close” binaries prevent planet formation?
- Are binary companions required for HJ formation, via Lidov-Kozai or similar?



Contaminating Light

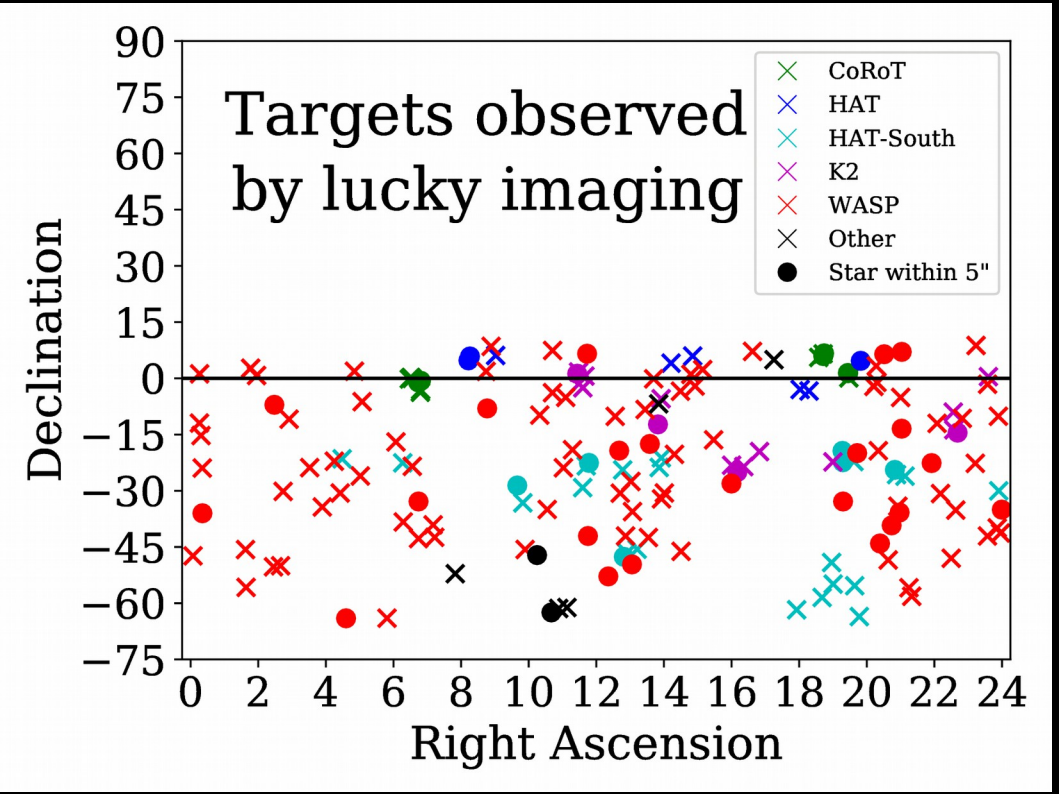
- All data (transit, RV, …) affected by contaminating light
- Bulk properties biased – smaller, lighter planet
- Transit dilution varies with wavelength! Is your transit deeper in the blue, or simply less diluted?



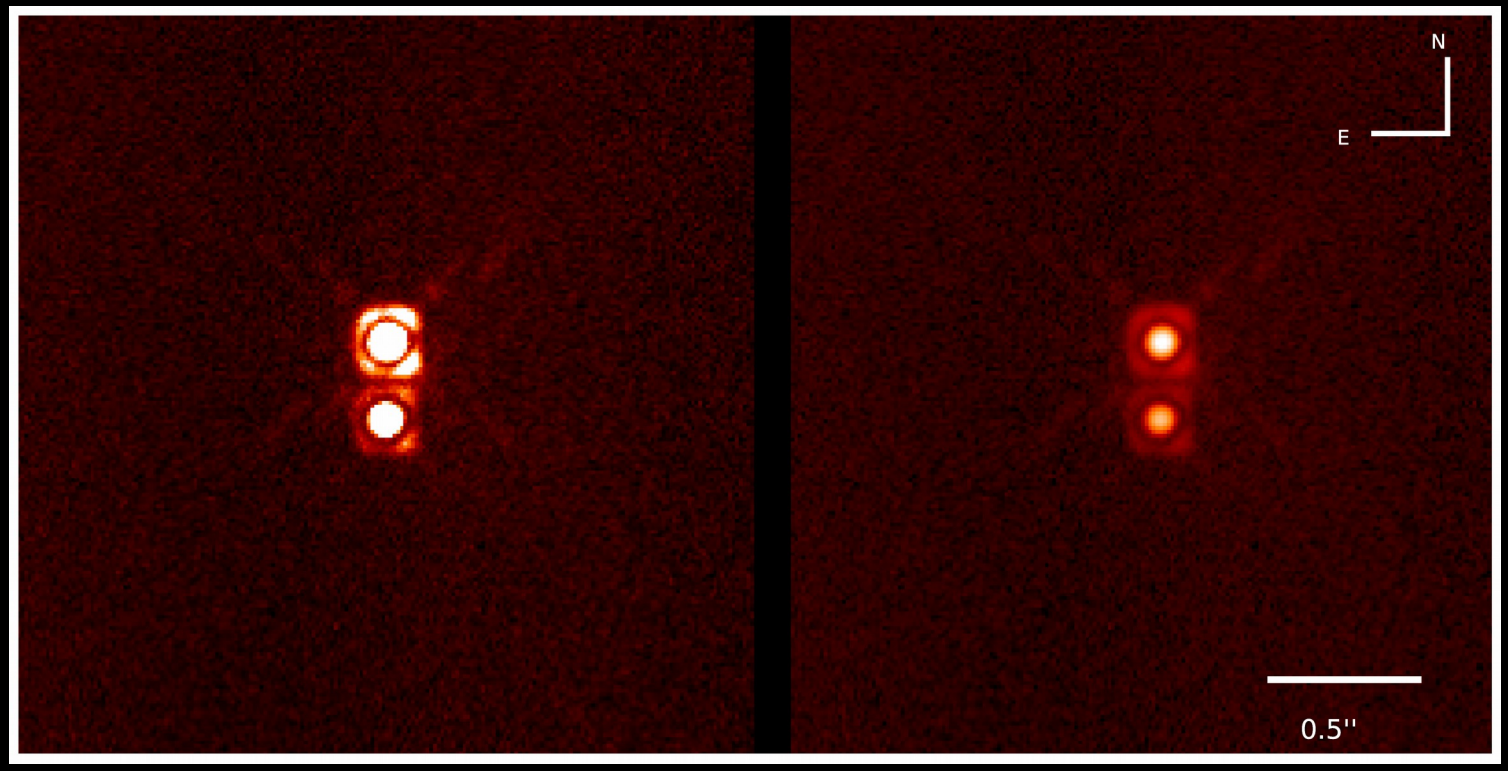
HITEP Survey

- Dual colour lucky imaging survey of 170 TEP systems (as of June 21) from La Silla
- 1 in 4 have a companion within 5 arcsec.

- Adaptive Optics survey using SPHERE/VLT, 42 targets observed, 6 scheduled
- Faint companions at ~0.2” trivially detected



WASP-20 is a wide binary with a planet



Separation 0.26”

ΔK = 0.84 mag

T_A = 6000K, T_B = 5040K

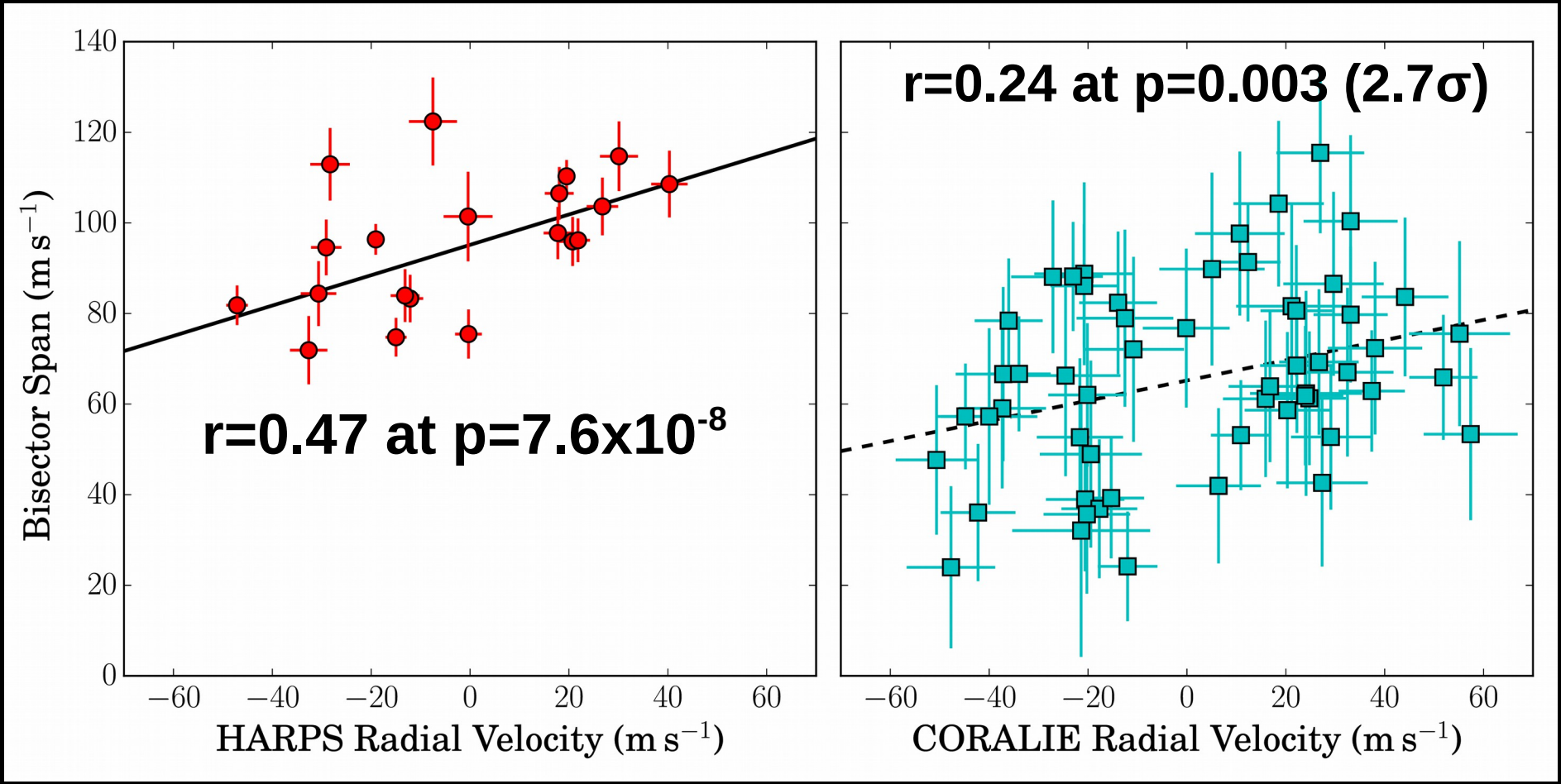
Entirely unsuspected in discovery paper

Planet mass 4x larger if planet orbits star B!

Evans et al. 2016, ApJL, 833, 19

Daniel Evans, Keele University
EWASS 2017, Prague – 27 June

Was WASP-20AB detectable?

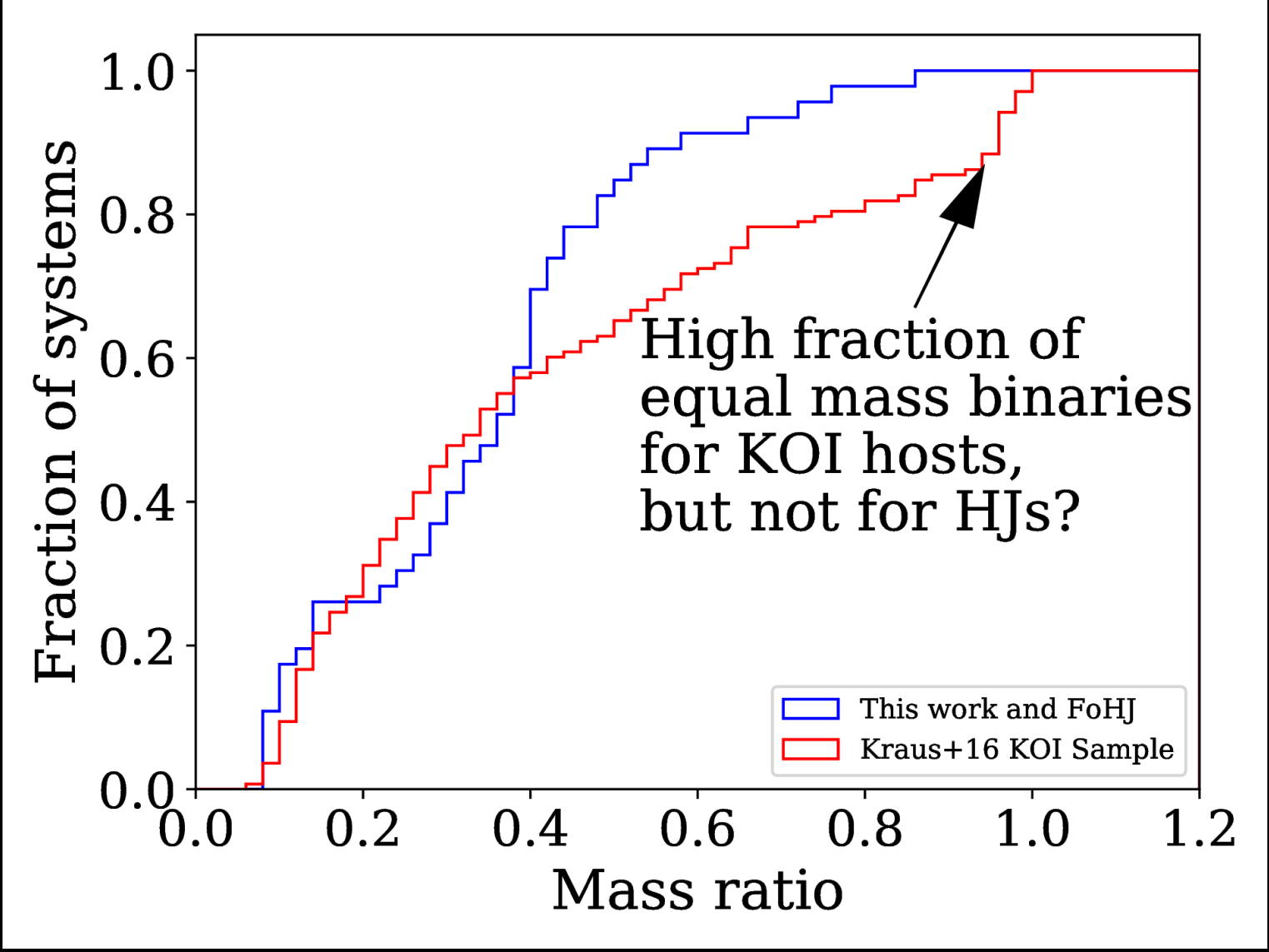


Discovery paper combined HARPS and CORALIE datasets

Highly significant RV-bisector span correlation if treated separately

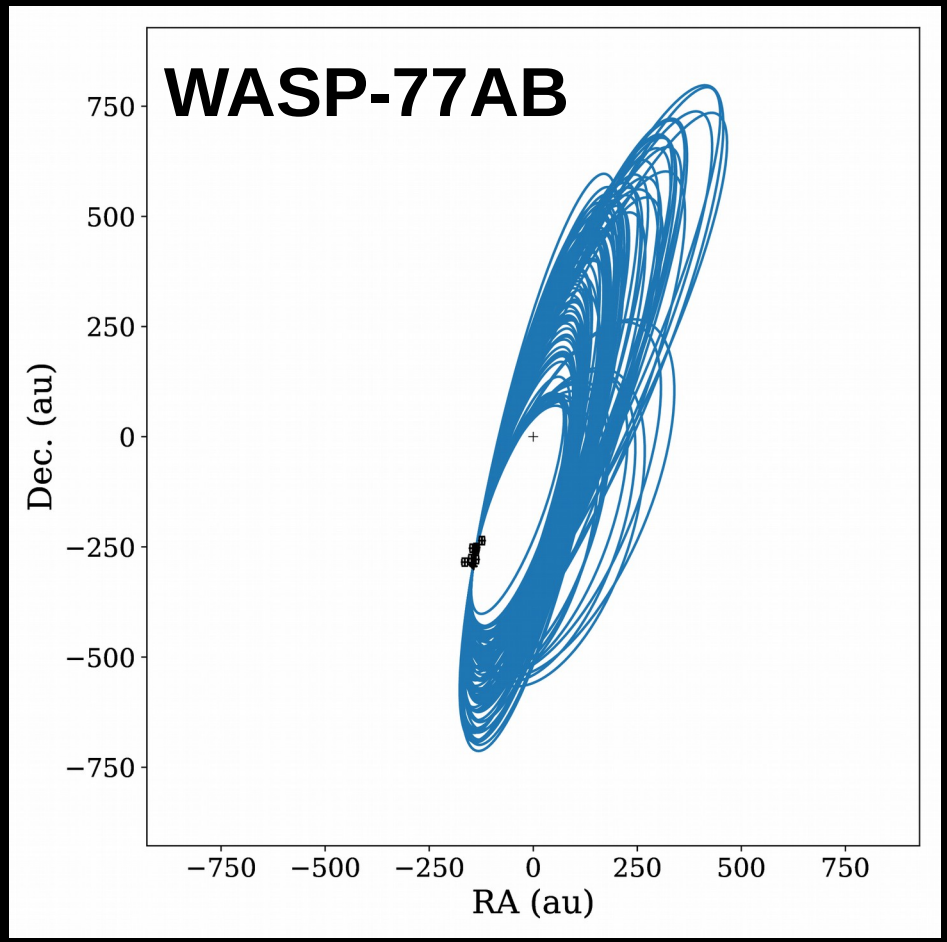
Daniel Evans, Keele University
EWASS 2017, Prague – 27 June

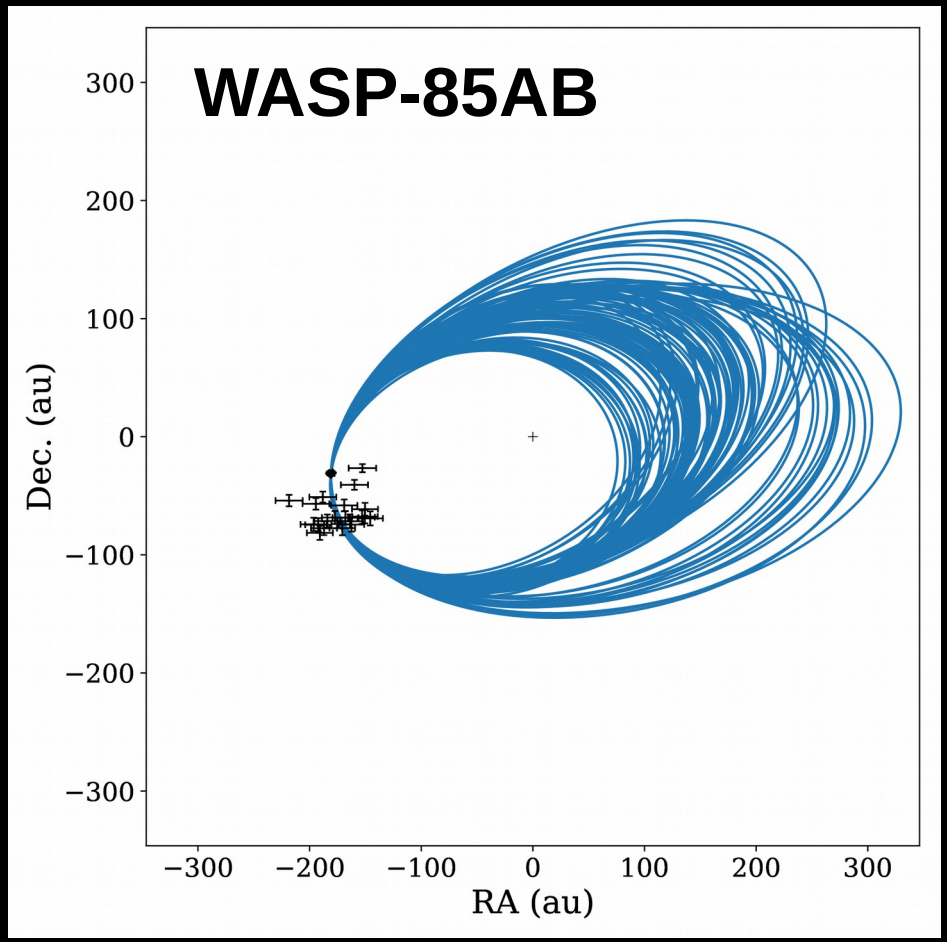
High mass companion stars are rare



Daniel Evans, Keele University
EWASS 2017, Prague – 27 June

Hot-Jupiter-hosting wide binaries have moderate eccentricities





a (au)	420 +250 -130
e	0.50 or 0.95
i (deg.)	75 +6 -15

a (au)	148 +52 -23
e	0.43 +0.13 -0.25
i (deg.)	140 +16 -12

Daniel Evans, Keele University
EWASS 2017, Prague – 27 June

Conclusions

- Contaminating light must be considered for atmospheric studies
- Even very bright companion stars can be difficult to detect!
- Hot Jupiters are found in different types of binaries to other planets (selection or real?)
- Wide binaries containing HJs can be eccentric, orbital planes are at least slightly different

Evans et al. 2016, A&A, 589, 58 (1603.03274)
Evans, Southworth & Smalley 2016, ApJL, 833, 19 (1611.08735)

Daniel Evans, Keele University
EWASS 2017, Prague – 27 June