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?

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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"
$\Delta K = 0.84$ mag
$T_A = 6000K, T_B = 5040K$

Entirely unsuspected in discovery paper
Planet mass 4x larger if planet orbits star B!


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Was WASP-20AB detectable?

Discovery paper combined HARPS and CORALIE datasets

Highly significant RV-bisector span correlation if treated separately

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High mass companion stars are rare

High fraction of equal mass binaries for KOI hosts, but not for HJs?
Hot-Jupiter-hosting wide binaries have moderate eccentricities.

WASP-77AB

- $a$ (au): 420 $^{+250}_{-130}$
- $e$: 0.50 or 0.95
- $i$ (deg.): 75 $^{+6}_{-15}$

WASP-85AB

- $a$ (au): 148 $^{+52}_{-23}$
- $e$: 0.43 $^{+0.13}_{-0.25}$
- $i$ (deg.): 140 $^{+16}_{-12}$

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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


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