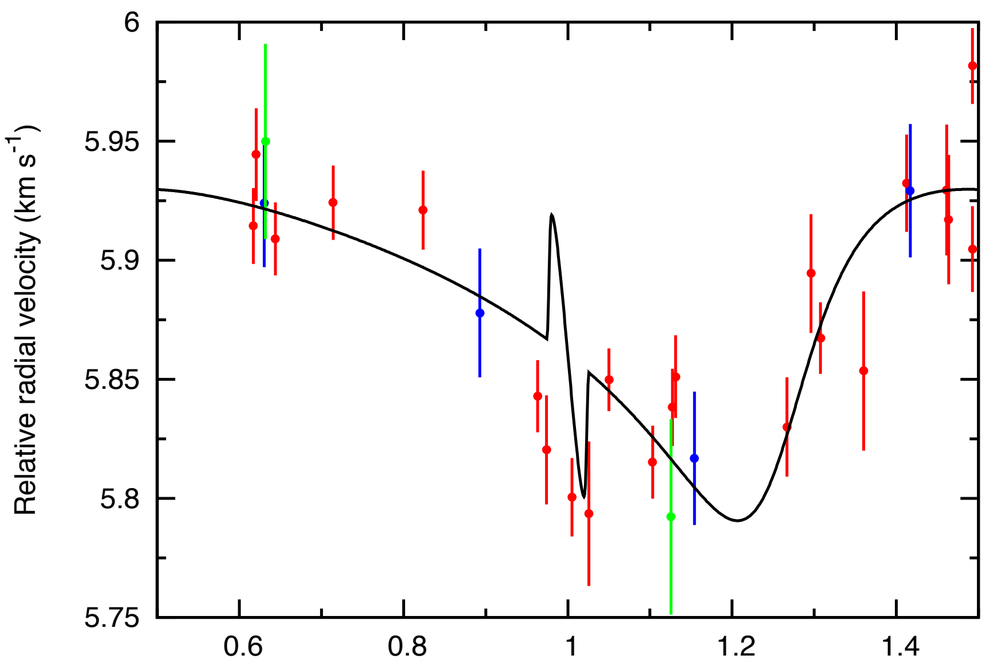
Is the eccentric WASP-118 system misaligned?

Kirstin Hay[1], A. Collier Cameron[1], A. Doyle[2], C. Hellier[3], D. Pollacco[2], R. West[2] & the WASP team
[1]School of Physics & Astronomy, University of St Andrews, KY16 9SS
[2]Department of Physics, University of Warwick, Coventry, CV4 7AL
[3]Physics and Astrophysics, School of Physical & Geographical Sciences, Keele University, ST5 5BG

Introduction

Close-orbiting gas giants are understood to form beyond the snow-line of their stellar host and then migrate inwards to their observed separations (Sasselov & Lecar 2000). Observations indicate a wide range of obliquities and eccentricities amongst the close-in Jovian type planet population. High obliquities are particularly found in systems with hot (T_{eff} > 6250 K) stellar hosts (Winn et al. 2010; Albrecht et al. 2012).

Planets with short periods and highly eccentric orbits are particularly interesting, as they are potentially in the final stages of tidal circularisation following Kozai oscillations.



Measured relative radial velocity as a function of transit phase for WASP-118. The RV points were observed from two telescopes -- data points in red were observed with the Coralie spectrograph on the Leonhard Euler Telescope; and the data points in green and blue were observed with SOPHIE on OHP with different calibrations. The eccentric shape of the RV curve can clearly be seen, and the couple of in-transit RV points are indicative of a high spin-orbit misalignment.

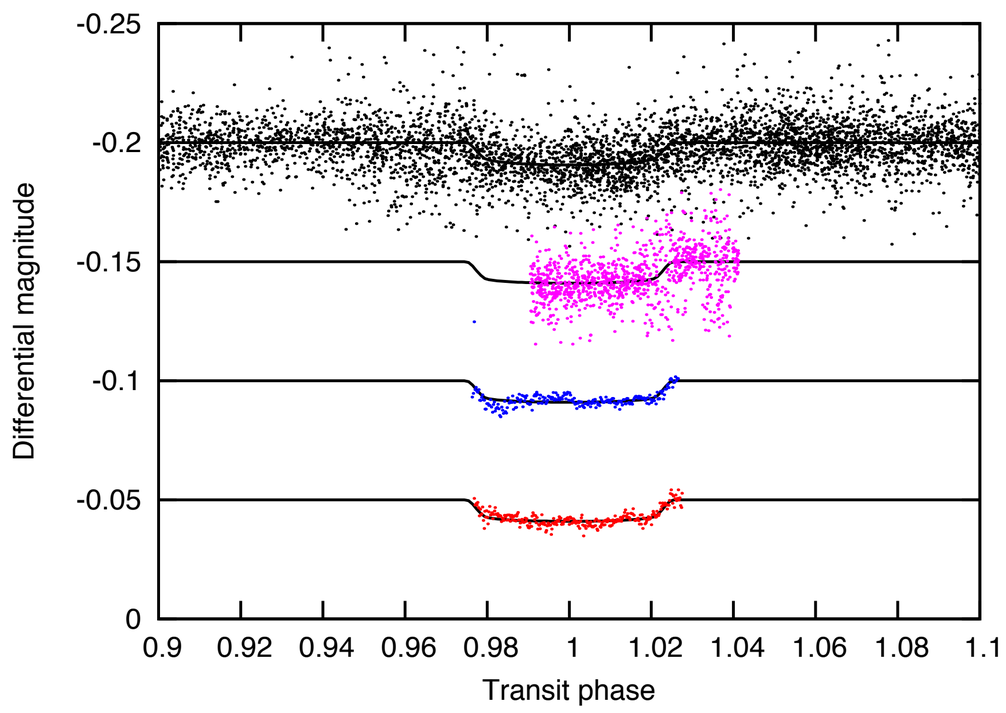
Measuring spin-orbit misalignment

The orientation of a planet's orbit relative to the sky-projected spin direction of the star (obliquity) can be measured through taking consecutive spectra during a transit (Queloz et al. 2000). The obscuration of a section of the stellar disk during transit results in a distortion of the radial velocity (RV) curve during the transit due to varying portions of the rotating stellar disk being blocked by the planet, which is known as the Rossiter--McLaughlin (RM) effect (eg. Triaud et al. 2010; Anderson et al. 2015). Where the portion of the stellar disk obscured is moving towards the observer, an increase in radial velocity is observed, and vice versa, thus the shape of the RV curve during transit is sensitive to the path of the planet across the disk relative to the stellar spin axis.

Further observations

High cadence radial velocity measurements during transit have been requested on HARPS-N on the TNG during 2015B, which will allow for the precise determination of the spin-orbit misalignment, and further precise radial velocity points throughout the orbital period will ascertain the exact orbital eccentricity.

WASP-118 will also be visible on an upcoming K2 campaign, from which high precision photometry will complement the radial velocity data acquired.



Phase-folded transit lightcurves for WASP-118. The upper plot is photometry from WASP, with the lower plots showing subsequent Z-band photometry from TRAPPIST and EulerCam respectively.

Fitting the system

WASP-118b is a transiting Hot Jupiter, found by the SuperWASP consortium, bringing together the WASP photometric data and radial velocity observations, an MCMC planet parameter fitting code was run in order to determine the appropriate system parameters. The data used are plotted on this poster, and the results of the fit are shown below.

The orbital period was well defined by the photometry and the fit for eccentricity was far more significant than assuming a circular orbit.

Parameter	Value	Units
Orbital period	4.04 ± 0.00	days
Transit duration	0.2018 ± 0.0030	days
Orbital eccentricity	0.45 ± 0.07	
Orbital separation	0.054 ± 0.005	AU
Impact parameter	0.32 ± 0.17	
Planetary density	0.30 ± 0.13	ρ_J
Stellar rotation speed	9.68 ± 1.10	km s^{-1}
Stellar density	0.40 ± 0.14	$\rho_\odot$

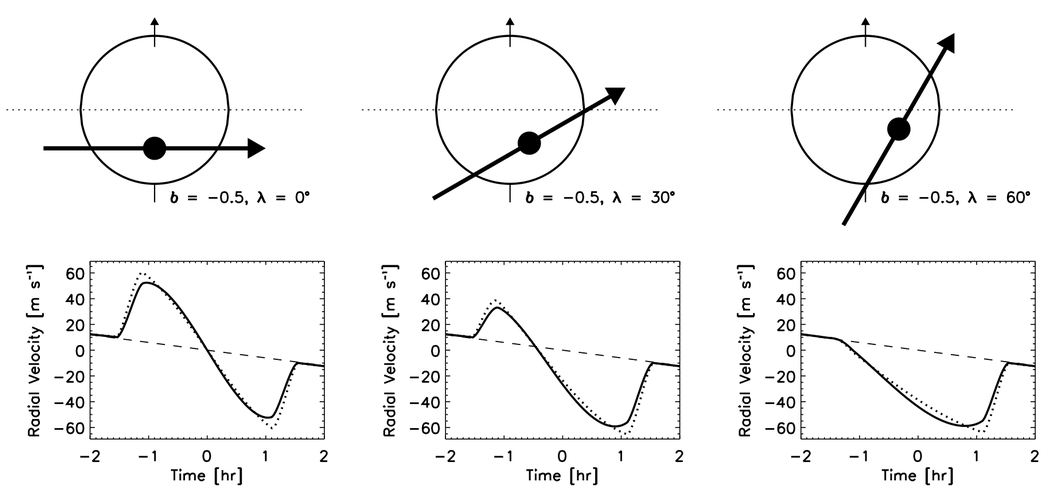


Diagram to indicate how the shape of the Rossiter McLauglin effect is dependent on misalignment angle. Diagram from Gaudi and Winn 2007.
The current RV data for WASP-118 is indicative of a near polar orbit, which makes further observations vital to fully understand this unusual system.

References
Albrecht et al. 2012, ApJ 774, 189; Anderson et al. 2015, ApJL 800, L6; Gaudi & Winn, ApJ 655, 550; Queloz et al. 2010, A&A 517, L1; Sasselov & Lecar 2000, ApJ 528, 995; Triaud et al. 2010, A&A 524, 25; Winn et al. 2010, ApJ 718, 14