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WASP-38b: A Transiting Exoplanet in an Eccentric, 6.87d Period Orbit

S. C. C. Barros[1], F. Faedi[1], A. Collier Cameron[2], T. A. Lister[3], J. McCormac[1], D. Pollacco[1], E. K. Simpson[1], B. Smalley[4], R. A. Street[3], I. Todd[1], A. H. M. J. Triaud[5], I. Boisse[6], F. Bouchy[6,7], G. Hébrard[6,7], C. Moutou[8], F. Pepe[6], D. Queloz[6], A. Santerne[8], D. Segransan[6], S. Udry[6], J. Bento[9], O. W. Butters[10], B. Enoch[2], C. A. Haswell[11], C. Hellier[4], F. P. Keenan[1], G. R. M. Miller[2], V. Moulds[1], A. J. Norton[11], N. Parley[2], I. Skillen[12], C. A. Watson[1], R. G. West[10], and P. J. Wheatley[9]

1 Astrophysics Research Centre, School of Mathematics & Physics, Queen's University Belfast, University Road, Belfast, BT7 1NN, UK e-mail: `s.barros@qub.ac.uk`
2 SUPA, School of Physics & Astronomy , University of St Andrews, North Haugh, St Andrews KY16 9SS, UK
3 Las Cumbres Observatory, 6740 Cortona Drive Suite 102, Goleta, CA 93117, USA
4 Astrophysics Group, Keele University, Staffordshire, ST5 5BG, UK
5 Observatoire de Geneve, Universite de Geneve, 51 Ch. des Maillettes, 1290 Sauverny, Switzerland
6 Institut d'Astrophysique de Paris, UMR7095 CNRS, Universite Pierre & Marie Curie, 75014 Paris, France
7 Observatoire de Haute-Provence, CNRS/OAMP, 04870 Saint-Michel l'Observatoire, France
8 Laboratoire d'Astrophysique de Marseille, Université d'Aix-Marseille & CNRS, 38 rue Frédéric Joliot-Curie, 13388 Marseille cedex 13, France
9 Department of Physics, University of Warwick, Coventry CV4 7AL, UK
10 Department of Physics and Astronomy, University of Leicester, Leicester, LE1 7RH
11 Department of Physics and Astronomy, The Open University, Milton Keynes, MK7 6AA, UK
12 Isaac Newton Group of Telescopes, Apartado de Correos 321, E-38700 Santa Cruz de la Palma, Tenerife, Spain

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ABSTRACT

Aims. We report the discovery of WASP-38b, a long period transiting planet in an eccentric 6.871815 day orbit. The transit epoch is 2455335.92050 ± 0.00074 (HJD) and the transit duration is 4.663 hours.

Methods. WASP-38b's discovery was enabled due to an upgrade to the SuperWASP-North cameras. We performed a spectral analysis of the host star HD 146389/BD+10 2980 that yielded T_{eff} = 6150±80 K, log g= 4.3±0.1, $v \sin i$=8.6±0.4 km s^{-1}, $M_* = 1.16\pm0.04\,M_\odot$ and $R_* = 1.33 \pm 0.03\,R_\odot$, consistent with a dwarf of spectral type F8. Assuming a main-sequence mass-radius relation for the star, we fitted simultaneously the radial velocity variations and the transit light curves to estimate the orbital and planetary parameters.

Results. The planet has a mass of 2.69 ± 0.06 M_{Jup} and a radius of 1.09 ± 0.03 R_{Jup} giving a density, $\rho_p = 2.1 \pm 0.1\,\rho_J$. The high precision of the eccentricity $e = 0.0314 \pm 0.0044$ is due to the relative transit timing from the light curves and the RV shape. The planet equilibrium temperature is estimated at 1292 ± 33 K. WASP-38b is the longest period planet found by SuperWASP-North and with a bright host star (V = 9.4 mag), is a good candidate for followup atmospheric studies.

Conclusions.

Key words. planetary systems – stars: individual: (WASP-38, HD 146389, BD+10 2980) –techniques: photometric, radial velocities

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1. Introduction

Transiting planets are important because the geometry of these systems gives us a wealth of information. Photometry during transit allows us to derive the inclination of the orbit and the radii of both the host star and planet. Combining this information with radial velocity variations allows us to derive the absolute mass of the planet and, hence, the density. Even just an estimation of the bulk density gives us an insight into the composition of the planet (Guillot, 2005; Fortney et al., 2007) and can be used to put constraints on planetary structure and formation models. These systems also offer a potential for measuring planetary emission spectra through occultation observations (e.g. Charbonneau et al. 2008) and we can gain an insight into the composition of planetary atmospheres using transit spectroscopy (Charbonneau et al., 2002; Vidal-Madjar et al., 2003; Swain et al., 2009).

For these reasons, there are several ground-based surveys searching for transiting exoplanets, such as HATNet (Bakos et al., 2004), TrES (Alonso et al., 2004), XO (McCullough et al., 2005) and WASP (Pollacco et al., 2006). Currently, there are also two space-based surveys: CoRoT (Baglin et al., 2006) and Kepler (Borucki et al., 2010). WASP is the most prolific of these surveys having discovered 38 of the 106 known transiting exoplanets. The WASP project consists of two robotic observatories: one in the Observatorio del Roque de los Muchachos, La Palma, Canary Islands, Spain and the other in the South African Astronomical Observatory of Sutherland, South Africa.

In this paper, we report the discovery of WASP-38b, an eccentric giant planet in a 6.87 day orbit. The candidate was identified in February 2010 in SuperWASP-North data. Radial velocity followup started at the end of March with *FIES* (2.6m NOT). The planetary nature of the object was established with *SOPHIE*

(1.93m OHP) and *CORALIE* (1.2m EULER) in May 2010. High precision photometry light curves were obtained with the Faulkes Telescope North (FTN) and Liverpool Telescope (LT).

WASP-38b is the 12th longest period of the 106 transiting exoplanets reported to date, and the fourth longest period of those discovered by ground-based observations. It was discovered after an upgrade to the SuperWASP-North cameras which we discuss in section 2.1. Therefore, WASP-38b is an important object whose properties add to the known transiting planets parameter space.

2. Observations

2.1. SuperWASP observations

The SuperWASP-North observatory in La Palma consists of 8 cameras each with a Canon 200-mm f/1.8 lens coupled to an Andor e2v 2048 × 2048 pixel back-illuminated CCD (Pollacco et al., 2006). This configuration gives a pixel scale of 13.7″/pixel which corresponds to a field of view of 7.8 × 7.8 square degrees per camera.

In October 2008, we introduced an electronic focus control and we also started stabilisation of the temperature of the SuperWASP-North camera lenses. Prior to this upgrade, night-time temperature variations affected the focal length of the lenses altering the FWHM of stars. This introduced trends in the data (mimicking partial transits), especially at the beginning and end of the night when the temperature variation is more extreme. These effects are not corrected by our detrending algorithms SYSREM (Tamuz et al., 2005) and FTA (Kovács et al., 2005) because they are position-dependent and do not affect all stars in the same manner. To reduce this source of systematic noise, heating strips were placed around each lens so that their temperature is maintained above ambient at 21 degrees. Besides the stabilisation of the temperature we also significantly improved the focus of each of the lenses, which now can be done remotely. This upgrade was successful and proved very important for the discovery of WASP-38b.

The field containing WASP-38 (HD 146389 / BD+10 2980 α =16:15:50.36 δ = +10:01:57.3) was observed in the period between 2008-03-29 and 2008-06-30 by camera 144 (3777 points) and camera 145 (3278 points). During this season, our transit search algorithm (Collier Cameron et al., 2006, 2007) did not detect the transit. In the following year, after the upgrade, observation of this field continued using the same cameras between 2009-03-30 and 2009-06-30. Camera 144 recorded 5920 observations and camera 145 recorded 2922. In the 2009 data, transits were detected using both cameras. The phase folded light curve using the 2009 SuperWASP data of WASP-38 is shown in the bottom panel of Figure 1. We also present the same for the 2008 SuperWASP data in the top panel, showing that the transit is also visible in the 2008 data. Comparing both data sets, we conclude that the somewhat higher rms (8.7mmag) of the 2008 data compared with the 2009 data (6.6mmag) prevented the detection of the transits in the first observing season.

Hence, we conclude that the upgrade was very successful in reducing the systematic noise of the SuperWASP-North cameras and allowed the discovery of a long period transiting planet. WASP-38b is the longest period transiting exoplanet found by SuperWASP-North. WASP-8b (Queloz et al., 2010) has a slightly longer period (P= 8.16 days) but was discovered by WASP South. Ground-based transiting surveys of exoplanets are biased towards shorter period planets due to their duty cycle and shorter transits. Reducing the systematic noise will be important in the discovery of long period and/or smaller radii planets.

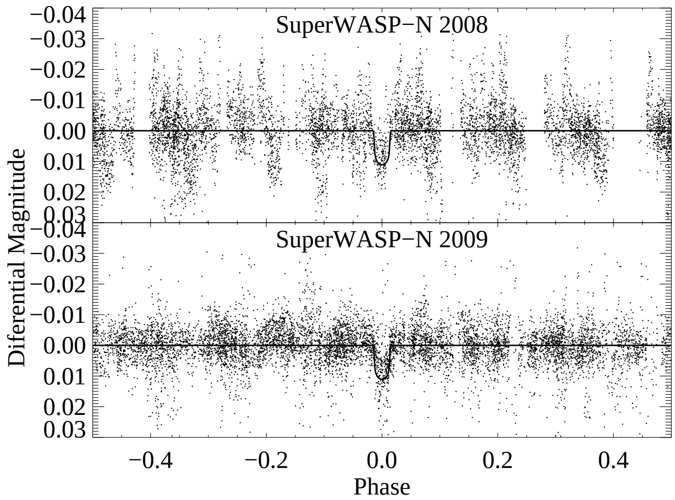

Fig. 1. SuperWASP phase folded light curve for WASP-38. On the top panel we show the 2008 data and on the bottom we show the 2009 data after the upgrade.

2.2. Spectroscopic followup

The first radial velocity measurements of WASP-38 were taken with the Fibre-Fed Echelle Spectrograph (*FIES*) mounted on the 2.56m Nordic Optical Telescope in La Palma. *FIES* was used in medium resolution mode (R = 46 000) with simultaneous ThAr wavelength calibration. Two observations were made on the nights of 2010-03-29 and 2010-03-30. On 2010 June 08 further nine observations were taken close to phase zero but out-of-transit. The observations were reduced with the FIEStool package and cross-correlated with a high signal-to-noise spectrum of the Sun to obtain the radial velocities.

The planetary nature of WASP-38b was established with *SOPHIE* mounted on the 1.93m telescope of the Observatoire de Haute Provence (Perruchot et al., 2008; Bouchy et al., 2009) and *CORALIE* on the 1.2m Swiss Euler telescope in La Silla (Baranne et al., 1996; Queloz et al., 2000; Pepe et al., 2002). Ten measurements were taken by *SOPHIE* and 16 by *CORALIE* between 2010 April and July, both achieving a signal-to-noise ratio of 30. The data was reduced with the *SOPHIE* and *CORALIE* pipelines, respectively. The radial velocity errors account for the photon noise plus known systematics in the high efficiency mode (Boisse et al., 2010).

The radial velocity measurements are given in Table 1. In Figure 2, we show the phase folded radial velocities from *FIES* (squares), *SOPHIE* (triangles) and *CORALIE* (circles). We superimpose the best fit Keplerian model described in section 3.2. In the same figure we show the residuals from the Keplerian model which show no long term trend. The semi-amplitude of the radial velocities is $\sim$ 250 m s^{-1} consistent with a 2.7 M_{Jup} planet in a slightly eccentric orbit.

A bisector span analysis was performed on the *SOPHIE* and *CORALIE* data and is shown in Figure 3. The bisector span shows no significant variation nor correlation with the radial velocities. This suggests that the radial velocity variations are mainly due to Doppler shifts of the stellar lines rather than stellar profile variations due to stellar activity or a blended eclipsing binary.

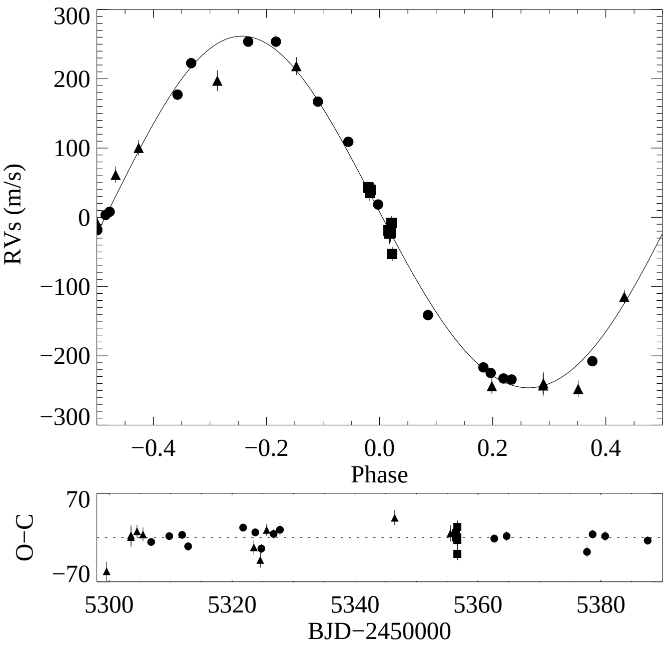

Fig. 2. Phase folded radial velocities of WASP-38 obtained with *FIES* (squares), *SOPHIE* (triangles) and *CORALIE* (circles). The centre-of-mass velocity for each data set was subtracted from the RVs. We also show the residuals from the orbital fit against time (bottom panel).

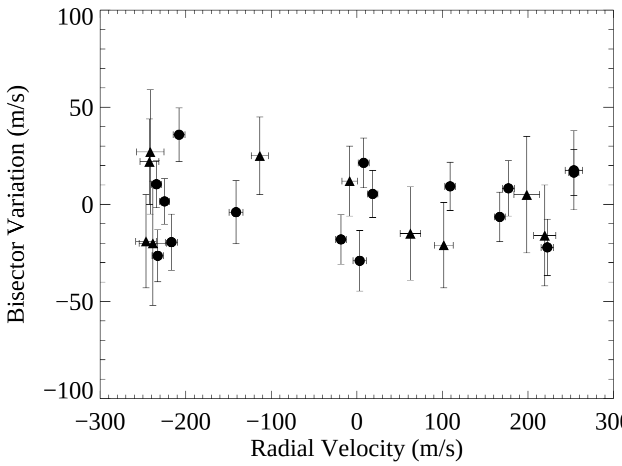

Fig. 3. Bisector span measurements for WASP-38 as a function of radial velocity for *SOPHIE* (triangles) and *CORALIE* (circles) data.

2.3. Photometric followup

To better constrain the system parameters, high precision transit light curves were obtained. The first photometric followup observations of WASP-38 were performed on 2010 May 19 using the LCOGT[1] 2.0m FTN located on Haleakala, Maui. The Spectral instrument was used which contains a Fairchild 4096×4096 pixel CCD which was binned 2×2 to give 0.304″ pixels and a field of view of $10' \times 10'$. Observations were taken through a Pan-STARRS z filter and the telescope was defocussed during the observations to prevent saturation and to increase the exposure time and reduce the effect of scintillation. The exposure time of the observations was 20 s. The DAOPHOT photometry package within IRAF was used to perform object detection and aperture photometry using a 16 pixel aperture radius. Differential photometry was performed relative to 23 comparison stars within the field-of-view.

[1] http://lcogt.net

Table 1. Radial velocities of WASP-38

BJD -2 450 000	RV (km s^{-1})	$\pm 1\,\sigma$ (km s^{-1})	V_{span} (km s^{-1})
	FIES NOT		
5285.6603	-9.678	0.010	
5286.7164	-9.526	0.008	
5356.3942	-9.800	0.010	
5356.4056	-9.801	0.009	
5356.4170	-9.808	0.011	
5356.4284	-9.804	0.010	
5356.6447	-9.862	0.012	
5356.6561	-9.867	0.015	
5356.6675	-9.865	0.014	
5356.6788	-9.851	0.010	
5356.6902	-9.896	0.010	
	SOPHIE OHP		
5299.58942	-9.510	0.015	0.003
5303.54816	-9.950	0.016	0.025
5303.55212	-9.947	0.016	-0.022
5304.53449	-9.822	0.010	0.023
5305.50502	-9.607	0.011	-0.023
5323.54137	-9.951	0.011	0.020
5324.58983	-9.955	0.012	-0.021
5325.62208	-9.717	0.009	0.010
5346.45645	-9.646	0.012	-0.017
5355.52441	-9.489	0.013	-0.018
	CORALIE Euler		
5306.836479	-9.5406	0.0059	-0.0225
5309.783314	-10.019	0.0059	-0.0374
5311.873800	-9.8128	0.0063	-0.0570
5312.849321	-9.6171	0.0071	-0.0307
5321.796623	-9.6852	0.0062	-0.0296
5323.780775	-10.0284	0.0061	-0.0286
5324.762705	-10.0020	0.0069	-0.0031
5326.759164	-9.5716	0.0073	-0.0611
5327.789065	-9.5406	0.0102	-0.0214
5362.657765	-9.6272	0.0064	-0.0454
5364.669083	-10.0109	0.0072	-0.0584
5377.739163	-9.9354	0.0081	-0.0429
5378.657251	-10.0269	0.0067	-0.0654
5380.693611	-9.7909	0.0078	-0.0680
5387.614500	-9.7862	0.0064	-0.0176
5404.620483	-9.7757	0.0061	-0.0336

Additional photometry was obtained on 2010 June 08 and 15 with a 18 cm Takahashi astrograph in La Palma. The CCD is an Andor 1024×1024 pixel e2v detector with 5.33″pixels and $1.5^{\circ} \times 1.5^{\circ}$ field of view. The observations were taken with the i' filter with an exposure time of 15 seconds. Images were bias and dark subtracted and flat field corrected with standard IRAF packages. We performed differential photometry relative to 5 comparison stars using DAOPHOT within IRAF.

On the night of 2010 June 15 we also observed WASP-38 with the high-speed CCD camera RISE mounted on the 2.0m Liverpool Telescope (Steele et al., 2008; Gibson et al., 2008). RISE has a wideband filter $\sim$ 500 - 700 nm which corresponds approximately to V+R. We obtained 3530 exposures in the 2×2 binning mode with an exposure time of 3.7 seconds and effec-

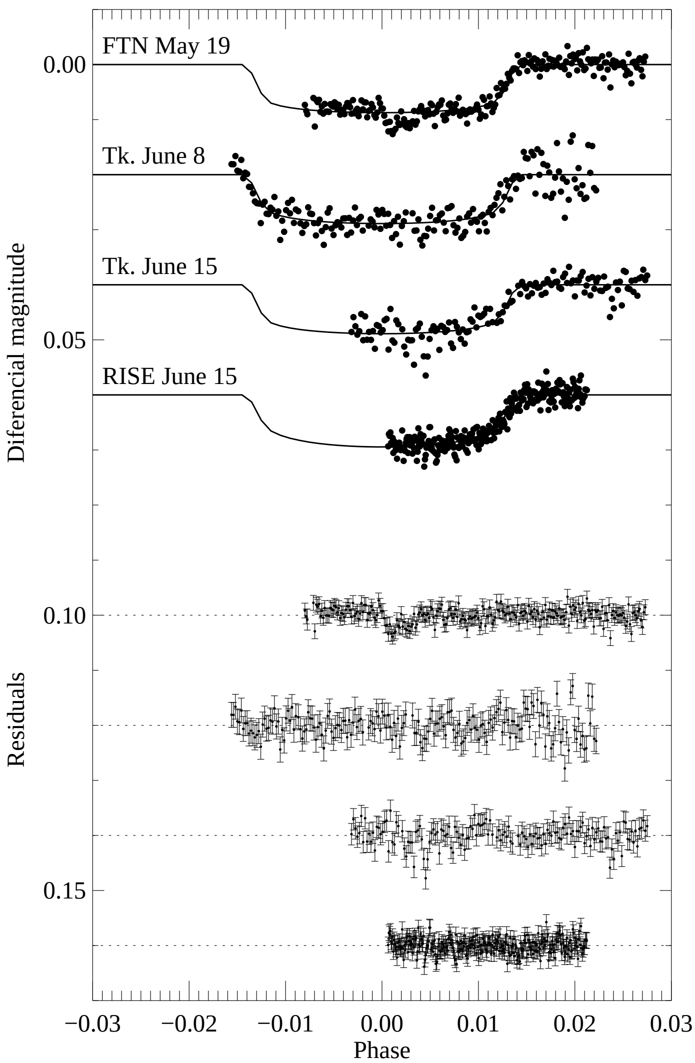

Fig. 4. Phase folded light curve for WASP-38. From top to bottom; FTN taken on the 2010 May 19, Takahashi (Tk.) astrograph taken on the 2010 June 8 and 15 and LT/RISE taken on the 2010 June 15. We superimpose the best-fit transit model and also show the residuals for each light curve on the bottom of the figure. The data were binned and displaced vertically for clarity.

tively no dead time. As usual, when using RISE for exoplanet transit observations, the telescope was defocussed by -1.2mm to spread the PSF over a larger number of pixels thereby increasing the signal-to-noise ratio. This resulted in a FWHM of $\sim 11''$. The data were reduced using the ULTRACAM pipeline (Dhillon et al., 2007) which is optimized for time-series photometry. Each frame was bias subtracted and flat field corrected. We performed differential photometry relative to seven nearby bright stars, all checked to be non-variable. We sampled different aperture radii and chose the aperture radius that minimised the noise which turned out to be a 24 pixel aperture radius (13″).

The final high precision photometric light curves are shown in Figure 4 along with the best-fit model described in section 3.2.

3. Results and system parameters

3.1. Stellar Parameters

WASP-38 (HD 146389, BD+10 2980) is listed as having spectral type F8 in the HD catalogue (Cannon & Pickering, 1921). This is consistent with that implied by the value of $B - V = 0.502$ given in the Tycho catalogue (Hoeg et al., 1997).

The *FIES* spectra were co-added to produce a single spectrum with a average signal-to-noise of around 200:1. Standard pipeline reduction products were used in the analysis.

The spectral analysis was performed using the methods given in Gillon et al. (2009). The H_α line was used to determine the effective temperature ($T_{\rm eff}$), while the Na I D and Mg I b lines were employed as surface gravity ($\log g$) diagnostics. Parameters obtained from the analysis are listed in Table 2. The elemental abundances were determined from equivalent width measurements of several clean and unblended lines. A value for microturbulence ($\xi_{\rm t}$) was determined from Fe I using the method of Magain (1984). The quoted error estimates include that given by the uncertainties in $T_{\rm eff}$, $\log g$ and $\xi_{\rm t}$, as well as the scatter due to measurement and atomic data uncertainties.

The projected stellar rotation velocity ($v \sin i$) was determined by fitting the profiles of several unblended Fe I lines. A value for macroturbulence ($v_{\rm mac}$) of 4.9 ± 0.3 km s^{-1} was assumed, based on the tabulation by Gray (2008), and an instrumental FWHM of 0.13 ± 0.01 Å was determined from the telluric lines around 6300Å. A best-fit value of $v \sin i = 8.6 \pm 0.4$ km s^{-1} was obtained.

We estimated the distance by comparing the V magnitude (V = 9.447) taken from Tycho (Hoeg et al., 1997) with the absolute magnitude of a F8-type star from Gray (1992).

Table 2. Stellar parameters of WASP-38 from spectroscopic analysis.

RA(J200)	16:15:50.36
DEC(J2000)	+10:01:57.3
V(mag)	9.447 ± 0.024
$T_{\rm eff}$	6150 ± 80 K
$\log g$ [cgs]	4.3 ± 0.1
$\xi_{\rm t}$	1.4 ± 0.1 km s^{-1}
$v \sin i$	8.6 ± 0.4 km s^{-1}
log A(Li)	1.93 ± 0.08
Mass [$M_\odot$]	1.16 ± 0.09
Radius [$R_\odot$]	1.26 ± 0.17
Spectral Type	F8
Distance	110 ± 20 pc
[Fe/H]	-0.12 ± 0.07
[Na/H]	-0.07 ± 0.07
[Mg/H]	-0.03 ± 0.07
[Si/H]	-0.01 ± 0.04
[Ca/H]	$+0.00 \pm 0.13$
[Sc/H]	-0.03 ± 0.16
[Ti/H]	-0.06 ± 0.12
[V/H]	-0.17 ± 0.09
[Cr/H]	-0.08 ± 0.11
[Mn/H]	-0.22 ± 0.12
[Co/H]	-0.17 ± 0.21
[Ni/H]	-0.14 ± 0.07

Note: Mass and radius estimate using the Torres et al. (2010) calibration. Spectral type from HD Catalogue.

3.2. Planet parameters

To determine the planetary and orbital parameters, we fitted all the photometry and radial velocity measurements simultaneously. Our model is an updated version of the Markov-Chain Monte Carlo (MCMC) fitting procedure described by Collier Cameron et al. (2007) and Pollacco et al. (2008). Our global fit uses the Mandel & Agol (2002) transit model parametrised by the transit epoch T_0, orbital period P, impact parameter b, transit duration T_T and squared ratio of planet radius to star radius $(R_p/R_*)^2$. For each photometric data set, we include the non-linear limb darkening coefficients for the respective filter based on the tables of Claret (2000, 2004). The Keplerian model for the host star's reflex motion is parametrised by the centre-of-mass velocity γ, the radial velocity amplitude K, the orbital eccentricity e and the longitude of the periastron w.

The main difference in the new version of our MCMC code is that the stellar mass is no longer an input parameter and is estimated from $T_{\rm eff}$, ρ_* and [Fe/H] using the calibration of Torres et al. (2010) as described in Enoch et al. (2010). While $T_{\rm eff}$ and [Fe/H] are input parameters derived from spectral fitting (Table 2), ρ_* is estimated at each point in the chain directly from the light curves.

Due to the poor quality of the only complete transit of WASP-38b we imposed a main-sequence mass-radius relation for the parent star, i.e. $R_* = M_*^{0.8}$ (Seager & Mallén-Ornelas, 2003; Cox, 2000) in our global fit. To better constrain the system parameters, a high precision complete transit light curve is needed. Unfortunately, due to its long transit duration there are not many full transits observable for this target and the only full transit visible from La Palma this season failed due to technical issues.

The system parameters of WASP-38 and the 1σ uncertainties derived from the MCMC analysis are given in Table 3. WASP-38b is a 2.691 $M_{\rm Jup}$ giant planet with an eccentric ($e = 0.031$) 6.87 day orbit. The planet radius is 1.09 $R_{\rm Jup}$, and hence, it has a high density of $2.06\,\rho_J$.

Table 3. WASP-38 system parameters.

Parameter	Value
Transit epoch T_0 [HJD]	2455335.9205 ± 0.00074
Orbital period P [days]	$6.871815^{+0.000045}_{-0.000042}$
Planet/star area ratio $(R_p/R_*)^2$	0.00712 ± 0.00018
Transit duration T_T [days]	$0.1942^{+0.0018}_{-0.0019}$
Impact parameter b [R_*]	$0.066^{+0.093}_{-0.046}$
Orbital inclination I [degrees]	$89.69^{+0.30}_{-0.25}$
Stellar reflex velocity K [m s^{-1}]	253.9 ± 2.4
Orbital semimajor axis a [AU]	$0.07522^{+0.00074}_{-0.00075}$
Orbital eccentricity e	$0.0314^{+0.0046}_{-0.0041}$
Longitude of periastron ω[degrees]	$-16.^{+18}_{-17}$
Stellar mass M_* [$M_\odot$]	1.203 ± 0.036
Stellar radius R_* [$R_\odot$]	$1.331^{+0.030}_{-0.025}$
Stellar surface gravity $\log g_*$ [cgs]	$4.250^{+0.012}_{-0.013}$
Stellar density ρ_* [$\rho_\odot$]	0.509 ± 0.023
Planet mass M_p [$M_{\rm Jup}$]	2.691 ± 0.058
Planet radius R_p [$R_{\rm Jup}$]	$1.094^{+0.029}_{-0.028}$
Planet density ρ_p [ρ_J]	2.06 ± 0.14

3.3. Eccentricity

The current version of our MCMC code uses the parameters $\sqrt{e}\cos\omega$ and $\sqrt{e}\sin\omega$ as jump parameters. This scaling allows the parameter space to be explored efficiently at small eccentricities, as recommended by Ford (2006), but ensures a uniform prior on e (Collier Cameron et al 2010, in prep).

From our global MCMC fit we derived an eccentricity of $0.0314^{+0.0046}_{-0.0041}$ which although being very small is significant at $7\,\sigma$. Given the small eccentricity we also tried fitting a circular orbit for WASP-38. The χ^2 value for the eccentric model fit is 77 while the χ^2 value for the circular model is 143. The eccentric model is parametrised by six parameters: γ, K, $e\cos\omega$, $e\sin\omega$ and two offsets to account for the shift between the zero points of the *FIES*, *SOPHIE* and *CORALIE*. The first two *FIES* points were excluded from the fit due to contamination from the moon hence we used a total of 35 RVs. Therefore, the Lucy and Sweeney test (Lucy & Sweeney, 1971) give a 99.99% probability for the eccentric orbit.

Interestingly if we fit only the radial velocities, the eccentricity is not significantly detected and the solution is compatible with a circular orbit. A more careful analysis of our data revealed that our high sensitivity to the eccentricity comes from the timing of the transit relative to the RV curve which places a tight constraint on $e\cos\omega = 0.0293 \pm 0.0036$ while $e\sin\omega$ is consistent with zero. This is contrary to the common assumption that the eccentricity is almost solely constrained by the RV curve. The transit of WASP-38 occurs $\sim$ 1.7 hours earlier than what was expected from the RVs if the orbit was circular. The timing shift is consistent for all of the followup light curves.

4. Discussion

The newly discovered planet WASP-38b is quite similar to the other currently known long-period transiting planets. It is massive (2.69 $M_{\rm Jup}$), has an eccentric orbit ($e = 0.031$) and does not suffer from the radius anomaly. For an updated list of the properties of these objects see Kovács et al. (2010). Only eleven out of the 106 transiting exoplanets have orbital periods longer than WASP-38b. Of these, five have been discovered by the CoRoT mission, two were found by Kepler (Holman et al., 2010), two were found in radial velocity surveys (HD17156b (Fischer et al., 2007; Barbieri et al., 2007) and HD80606b (Naef et al., 2001; Moutou et al., 2009; Fossey et al., 2009; Garcia-Melendo & McCullough, 2009)) and the remaining three are WASP-8b, HAT-P-15b (Kovács et al., 2010) and HAT-P-17b (Howard et al., 2010). Therefore, WASP-38b is the forth exoplanet with a period longer than six days discovered in a ground-based transit survey.

The low number of transiting planets with periods longer than five days is mostly due to selection effects. It is widely known that the transit probability decreases with period. Moreover, for ground-based surveys (which are responsible for the discovery of 72% of the transiting planets), the detection probability also steeply decreases with period. This is due to the longer duty cycle of the transits and longer transit duration coupled with the restricted observing time from a single site on Earth. To increase the duty cycle of the observations, telescope networks spread in geographic latitude or space-based surveys are needed. In the case of WASP-38b it was very important to reduce the systematic noise which ultimately allowed the discovery of the planet. However, the selection effects might be hiding a real decrease of the number of planets at longer periods. In fact, from radial velocity surveys there appears to be a depletion of planets between $\sim 0.1 - 1$AU (Udry et al., 2003).

The low lithium abundance, $logA(Li) = 1.93$ points to an age of > 5 Gyr for WASP-38 (Sestito & Randich, 2005). However, it has been shown (Israelian et al., 2009) that stars with planets have an under-abundance of lithium compared with stars without planets. Therefore, in this case, the lithium abundance might be overestimating the age. In fact, if we estimate the age from the rotation period (~ 7.5 days), we obtain ~ 1 Gyr from Barnes (2007) (using Tycho B-V=0.5). Unfortunately, our light curves are not good enough to constrain the radius of the star. As mentioned above, we had to assume the mass-radius relation for the main-sequence in our parameters fit. Hence, we cannot use the stellar radius to calculate the isochrone age. Further observations are needed in order to better constrain the age and the evolutionary status of the star.

WASP-38b is very dense but not atypically so for a massive planet. Its equilibrium temperature is 1292 ± 33 K which is quite hot for a long period planet due to its "hot" F8 host star that has a luminosity $\sim 2.4 L_{\odot}$. To receive the same flux in our solar system the planet would have to be at 0.049AU from the Sun. WASP-38b is a "pL" class planet according to the classification of Fortney et al. (2008). Therefore, we expect an efficient re-distribution of heat from the day side to the night side of the planet and no temperature inversion in the atmosphere.

A better insight on the planet composition will require a better constraint on its age. According to the Fortney et al. (2007) models, if WASP-38b is $\sim$ 1Gyr old it might have a substantial core with a mass up to 100 Earth masses. However, if the planet is much older (4.5Gyr) its radius is consistent with a hydrogen/helium coreless planet. A better estimation of the radius of the planet will also help constrain its composition. Given that the star is metal poor, it would be interesting to determine the existence of a core.

The Safronov number for WASP-38b is $\sim$ 0.3 (Hansen & Barman, 2007). With the exception of CoRoT-4b, all the transiting planets with a period longer than WASP-38b have Safronov numbers larger than 0.3 and hence they do not belong to either of the classes proposed by Hansen & Barman (2007).

Due to its long period it is not surprising that WASP-38b is slightly eccentric. As discussed above, the eccentricity however small is significant. The circularization timescale is given by (Goldreich & Soter, 1966; Bodenheimer et al., 2001):

$$\tau_{\rm CIR} \approx 0.63 \left(\frac{Q_p}{10^6}\right)\left(\frac{M_p}{\rm M_{Jup}}\right)\left(\frac{M_{\odot}}{M_*}\right)^{3/2}\left(\frac{a}{10R_{\odot}}\right)^{13/2}\left(\frac{\rm R_{Jup}}{R_p}\right)^5 Gyr. \quad (1)$$

From studies of binary stellar evolution (Meibom & Mathieu, 2005) and from our Solar System (Goldreich & Soter, 1966; Peale, 1999), the tidal dissipation parameter is $Q_p = 10^5 - 10^6$. Therefore, for WASP-38b the circularisation timescale is between $\sim 1.9 - 19$ Gyr which is consistent with our constraint on the age of WASP-38 and can be compared to the main-sequence lifetime for an F8 star ($\sim$ 9 Gyr). Therefore, depending on the value of Q_p, WASP-38b's orbit might never circularise, as it appears to be at the limit of circularisation. All longer period transiting planets are eccentric or the eccentricity has been fixed to zero. A better constraint on the age of WASP-38 might be important to constraint the tidal dissipation parameters, so further studies are encouraged.

WASP-38 is a bright star (V= 9.4 mag) and therefore is a good candidate for followup observations. The secondary transit is predicted to be at phase 0.520 ± 0.002, $T_0 = 2455456.3055 \pm 0.015$ and have a duration of 274.5 ± 5.0 minutes. Next year, the only full transit visible from La Palma is on 2011 April 21. Observations of a spectroscopic transit to measure the Rossiter-McLaughlin effect were obtained in 2010 June by one of our co-authors and will be presented elsewhere (Simpson et al. 2010, in prep.).

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