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Transit observations with the three San Pedro Mártir telescopes

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Abstract. Exoplanetary transit observations were carried out for the first time with all the three telescopes at the San Pedro Mártir National Astronomical Observatory in Baja California, Mexico.

We present preliminary results on WASP-39 and WASP-43, two Hot Jupiters known for the presence of a highly-inflated radius. Using the defocused photometry technique, we observed these systems, achieving photometric precision of ±3–5mmag peak-to-valley. The preliminary fit of their lightcurves shows physical and orbital parameters consistent with published results.

Keywords. techniques: photometric, exoplanets

1. Introduction

In the framework of a campaign for the observation of extrasolar planets, in the first semester of 2014 we successfully obtained light curves of 15 transiting systems, some of which present peculiar features.

For the first time the three San Pedro Mártir telescopes at the Observatorio Astronomico Nacional (Baja California, Mexico) were involved in this kind of research: the traditional 84cm telescope, the robotic 1.5m, and the traditional 2.12m provided with active optics on the primary mirror. This represents a unique opportunity in the northern hemisphere for the follow-up of dedicated surveys such as SuperWasp and HAT, but also for alert of forthcoming programs such as TAOS-II (see Lehner *et al.* (2013)). The selected objects are of the Hot Jupiter-type, and are characterized in the literature with clues of a strong interaction with their parent star such as a highly inflated radius. Here, we focus on WASP-39 and WASP-43. In the case of WASP-39, the presence of an accretion disk around the parent star is also indicated in the literature We present a preliminary analysis of these two systems, which have been extensively observed during our ongoing survey.

2. Observations, data reduction and analysis

The observations were carried on in a wide range of photometric bands using the defocused photometry method (Southworth *et al.* (2014)). Concerning WASP-39, we observed the same transit in the Johnson U filter with the 2.12m telescope, and in the I filter with the 84cm telescope, while an additional transit was observed in the R filter with the 84cm telescope. Concerning WASP-43, five transits were observed with the 84cm telescope: one in the Johnson V filter, two in the R filter, and two in the I filter. An

Table 1. Result of the fit of the orbital and physical parameters of WASP-39 and WASP-43.

Parameter	filter		WASP-39	WASP-43
Orbital inclination		i [deg]	87.78 ± 0.43	81.92 ± 0.54
Scaled Semi-major Axis		a/R_*	11.3242 ± 0.4237	4.815 ± 0.114
	U	R_p/R_*	0.1462 ± 0.0116	
	V	R_p/R_*		0.1615 ± 0.0041
Planet / Star radius ratio	R	R_p/R_*	0.1424 ± 0.0023	0.1599 ± 0.0025
	I	R_p/R_*	0.1424 ± 0.0023	0.1653 ± 0.0054
	i	R_p/R_*		0.1738 ± 0.0033

additional observation was carried out the same night as the later R observation, but in the SDSS i filter used with the 1.5m telescope. We then reduced the data using the aperture photometry technique with the IDL pipeline `defot` (Southworth *et al.* (2014)), and we compared the results with standard IRAF procedures developed by our team, finding consistent results. As reference star for photometry, we used for each target the field star closest in terms of flux and color index. The shape of the defocused PSFs allowed to calculate the FWHM of the target and of the reference stars. This information was used to dynamically adjust the aperture during the reduction with the IRAF pipeline. We used an aperture diameter of 2.5 times the previously calculated FWHM on each image frame. The light curves were corrected for slight trends that we attribute to differential extinction between target star and reference star. The value of HJD reported in the `fits` header was converted to BJD. We used the IDL software TAP by Gazak *et al.* (2011), a Monte Carlo method using the Mandel & Agol(2002) model, to fit the light curves, in order to obtain physical and orbital parameters. Each system was fitted using a set of fixed parameters and varying other parameters after providing initial guesses. We fixed the period, the limb darkening, the eccentricity and the argument of periastron ω. We varied the inclination, the scaled semi-major axis, and the mid-transit time, fitting together the curves for each of the observed systems. Finally, we varied the star/planet radius, fitting separate values for each filter. In the fit parameters, the eccentricity and ω were fixed to 0, and the limb darkening was calculated using the Exofast (see Eastman *et al.* (2012)) online tool. The other fixed values and the initial guesses were taken from the most recently published results: Faedi *et al.* (2011) for WASP-39, and Chen *et al.* (2014) for WASP-43.

3. Results

We obtain a photometric accuracy (peak-to-valley) of 3mmag with the 2.12m telescope, and of ±5mmag with the 84cm and 1.5m telescopes. Our results are shown in Table 1, and they are in agreement with previous studies. In particular, we find for WASP-43 a slight dependence of the planet/star radius on the photometric band. Although the variation is within the error bars, we are planning additional observations in order to investigate this effect in more detail. Moreover, we are ready to apply a genetic algorithm developed by Cantó *et al.* (2009) to our data.

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