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The photometric follow-up observations for transiting exoplanet XO-2b

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Abstract. Four new transit light curves of XO-2b obtained in 2008 and 2009, are analyzed by using MCMC algorithm, and the system parameters are derived. The result demonstrates that the orbital period of the system obtained from new observations is almost the same as Burke et al.’s one (2007), which does not confirm the result of Fernandez et al. (2009).

Keywords. planetary systems, eclipses, techniques: photometric

1. Introduction

The transiting hot Jupiter XO-2b was discovered by Burke et al. (2007), its radius, mass and orbital period are 0.98R_J, 0.57M_J and 2.615857 days, respectively, the host star XO-2 has high metallicity and high proper motion. Later, Fernandez et al. (2009) observed other six transit events of the system and derived precise radius 0.996R_J and mass 0.565M_J of the exoplanet. They also found that the orbital period of the system changed by 2.5σ. Thus, more observations for its transit events are needed to clarify whether the orbital period of the system is variable.

2. Observations and data reduction

The new observations for transit events of XO-2b were made by using 85cm telescope with 1Kx1K CCD camera (Zhou et al. 2009) of Xinglong station, NAOC on Dec.3, 2008 and 1m telescope with 1Kx1K, 2Kx2K CCD cameras of Yunnan Observatory on Jan.19, 2008, Dec.7,12, 2009. In all observations, the R filter was employed. The observed CCD images are reduced by using IRAF package. For the obtained light curves, we remove the systematic errors by using coarse decorrelation method (Collier Cameron et al. 2006) and SysRem algorithm (Tamuz et al. 2005).

3. Light curve analysis and discussion

In order to get a set of precise system parameters for XO-2, the 4 datasets of transit events are combined in the course of light curve analysis. We model the flux of the transiting system with the parameters \{T_c, p, ΔF, t_T, b, M_*\} considering the 4-coefficient limb-darkening law of Claret (2000). The basic parameters of the host star are adopted from the recent relative results (Fernandez et al. 2009). All observed data points are involved in MCMC (Markov Chain Monte Carlo) analysis to search the optimal parameters \{T_c, p, ΔF, t_T, b, M_*\} according to the procedure of Collier Cameron et al. (2007).
Table 1. The optimal parameters derived for XO-2 system using the MCMC algorithm.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Transit epoch T&lt;sub&gt;c&lt;/sub&gt; [HJD]</td>
<td>2455013.5983&lt;sup&gt;±&lt;/sup&gt;0.0003&lt;sup&gt;−&lt;/sup&gt;−0.0002</td>
</tr>
<tr>
<td>Orbital period p</td>
<td>2.6158553&lt;sup&gt;±&lt;/sup&gt;2.2E−06&lt;sup&gt;−&lt;/sup&gt;−2.5E−06 days</td>
</tr>
<tr>
<td>Transit depth ΔF</td>
<td>0.0136&lt;sup&gt;±&lt;/sup&gt;0.0002&lt;sup&gt;−&lt;/sup&gt;−0.0002 mag.</td>
</tr>
<tr>
<td>Transit width t&lt;sub&gt;T&lt;/sub&gt;</td>
<td>0.1094&lt;sup&gt;±&lt;/sup&gt;0.0005&lt;sup&gt;−&lt;/sup&gt;−0.0003 days</td>
</tr>
<tr>
<td>Impact parameter b</td>
<td>0.139&lt;sup&gt;±&lt;/sup&gt;0.021&lt;sup&gt;−&lt;/sup&gt;−0.070 R&lt;sub&gt;*&lt;/sub&gt;</td>
</tr>
<tr>
<td>Orbital separation a</td>
<td>0.0367915&lt;sup&gt;±&lt;/sup&gt;1.3E−06&lt;sup&gt;−&lt;/sup&gt;−1.1E−06 AU</td>
</tr>
<tr>
<td>Orbital inclination i</td>
<td>89.045&lt;sup&gt;±&lt;/sup&gt;0.485&lt;sup&gt;−&lt;/sup&gt;−0.147 degrees</td>
</tr>
<tr>
<td>Stellar radius R&lt;sub&gt;*&lt;/sub&gt;</td>
<td>0.951&lt;sup&gt;±&lt;/sup&gt;0.001&lt;sup&gt;−&lt;/sup&gt;−0.003 R&lt;sub&gt;Sun&lt;/sub&gt;</td>
</tr>
<tr>
<td>Planet radius R&lt;sub&gt;p&lt;/sub&gt;</td>
<td>0.945&lt;sup&gt;±&lt;/sup&gt;0.006&lt;sup&gt;−&lt;/sup&gt;−0.007 R&lt;sub&gt;Jup&lt;/sub&gt;</td>
</tr>
<tr>
<td>Stellar mass M&lt;sub&gt;*&lt;/sub&gt;</td>
<td>0.971 M&lt;sub&gt;Sun&lt;/sub&gt;</td>
</tr>
<tr>
<td>Planet mass M&lt;sub&gt;p&lt;/sub&gt;</td>
<td>0.565 M&lt;sub&gt;Jup&lt;/sub&gt;</td>
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Figure 1. Binned light curve of XO-2b and fitting information.

final result is listed in Table 1, the relative fitting and other information are shown in Fig. 1.

Compared our new result and the previous ones, it can be found that the new orbital period is almost the same as Burke et al.’s value (2.615857 days). This does not support the suggestion that the orbital period of the system is probably variable, which was given by Fernandez et al. (2009). So, it is still necessary to observe more transit events for XO-2b so as to make further investigation on its period behavior.

Acknowledgments

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References