

## Observations of planetary transits at the University Observatory Jena

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**Abstract.** We report on observations of transit events of the transiting planets XO-1b, TrES-1 and TrES-2 with a 25 cm telescope of the University Observatory Jena. With the help of all available transit times from literature including our own photometry our measurements allowed us to refine the estimate of the orbital period of all three transiting planets observed by us.

### 1. INTRODUCTION

In this work we use the transit method to observe known transiting planets at the University Observatory Jena. We paid special attention to the accurate determination of transit times in order to identify precise transit timing variations that would be indicative of perturbations from additional bodies ([1]) and to refine the orbital parameters of the systems. First results were presented in [2] and [3].

Here, we present results for XO-1b, TrES-1 and TrES-2 that we obtained from our observations with a 25 cm telescope at the University Observatory Jena.

### 2. OBSERVATIONS

Most observations were carried out at the University Observatory Jena which is located close to the village Großschwabhausen, 10 km west of the city of Jena. [4] describes the instrumentation and operation of the system. Our transit observations are carried out with the CTK (*Cassegrain Teleskop Kamera*), the CCD imager operated at the 25 cm auxiliary telescope of the University Observatory Jena.

### 3. XO-1B

XO-1b was the first transiting planet observed at the University Observatory Jena. Between March 2007 and May 2009 four transit events were observed. With an exposure time of 60 s we achieve a mean cadence of the data points of 1.4 min. Our mean photometric precision is 0.007 mag. In addition to the

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transits observed at the University Observatory Jena we could find 54 transit times from 2004–2009 in the literature ([5–7], ETD<sup>1</sup>). Through timing residuals analysis we find that the orbital period is slightly smaller compared to the previously published period. Thus, our measurement of the transit time lead to a refined estimate of the ephemeris:

$$T_c(E) = (2453808.91705 + E \cdot 3.941501) \text{ d.} \quad (1)$$

#### 4. TrES-1

We observed three transits of TrES-1 in front of it's parent star with our 25 cm Cassegrain telescope. Our mean photometric precision of the  $V = 11.79$  mag star is 0.009 mag. For TrES-1 we found 52 midtransit times between 2003 and 2009 in the literature ([8–12], ETD). With all available times of these altogether 55 transits we determined the transit timing residuals for TrES-1. This allowed us to refine the estimate of the ephemeris:

$$T_c(E) = (2453186.806341 + E \cdot 3.0300722) \text{ d.} \quad (2)$$

#### 5. TrES-2

Since March 2007 13 different transits were observed. All TrES-2 observations were taken in *I*-band with 60 s exposure time. The mean photometric accuracy of the  $V = 11.4$  mag bright TrES-2 host star is 0.007 mag. With the transit timings for TrES-2 from 40 events published in literature ([13, 14], ETD) plus our own 13 transits, we found that the orbital period slightly lower ( $\sim 0.6$  s) compared to the previously published period. The resulting ephemeris which represent our measurements best is:

$$T_c(E) = (2453957.63492 + E \cdot 2.470614) \text{ d.} \quad (3)$$

### 6. SUMMARY AND CONCLUSIONS

Using our observations at the University Observatory Jena with a 25 cm Cassegrain telescope equipped with the optical CCD camera CTK we could observe the known planetary transits of XO-1b, TrES-1 and TrES-2. In all three cases our measurement of the transit times lead to a refined estimate of the ephemeris, improved by 0.1 s, 0.6 s and 3 s for TrES-1, TrES-2 and XO-1b, respectively.

The mean photometric precision of the observed stars ( $V = 11$ – $12$  mag) with known transiting planets is 0.008 mag and the precision in the determination of the transit times is  $\sim 0.0013$  d. This allows us to register transit time variations of around  $\sim 2$  min.

We will continue observing stars with known transiting planets to search for transit time variations for the next few years to decades, also using a new, better CCD-camera with our 60 cm Schmidt telescope.

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<sup>1</sup> Exoplanet Transit Database, <http://var.astro.cz/ETD>

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