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Searching for planets around eclipsing binary stars using timing method: NSVS 14256825

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Abstract. We present four new mid eclipse times and an updated O-C diagram of the short period eclipsing binary NSVS14256825. The new data follow the (O-C) trend and its model proposed in Nasiroglu *et al.* (2017). The (O-C) diagram shows quasi-periodic variations that can be explained with the presence of a brown-dwarf in a quasi-circular circumbinary orbit.

Keywords. binaries: eclipsing, ephemerides, planetary systems, NSVS14256825

1. Introduction

Eclipse timing observations have provided evidence of third bodies orbiting binary systems through the Light Travel Time (LTT) effect. These deviations can be measured with a high accuracy and used to infer the presence of low-mass compaions (Irwin 1952, Goździewski *et al.* 2012, 2015).

The post-common envelope binary NSVS 14256825 is a member of the HW Vir family with a period of 2.65 hrs, consisting of a OB sub-dwarf and a M dwarf companion (Almeida *et al.* 2012). The cyclic behaviour of the (O-C) eclipse timings in NSVS 14256825 was attributed to one or two Jovian-type circumbinary planets (Beuermann *et al.* 2012, Almeida *et al.* 2013). However, the orbital stability of a 2-planet system was found strongly unlikely by Wittenmyer *et al.* (2013). Moreover, Hinse *et al.* (2014) also performed a detailed analysis and they concluded that the time span of timing measurements is not long enough to constrain the proposed planets. In this study, we present four new eclipse times (Tab. 1) that follow the trend of the (O-C) diagram shown recently by Nasiroglu *et al.* (2017). The observations were performed at the TUBITAK National Observatory (TUG, T100) and at the Adiyaman University Observatory (ADYU60) in Turkey.

2. Data and LTT Model

Nasiroglu *et al.* (2017) presented 83 new eclipse timings of NSVS 14256825 which extended the time span of previous (O-C) diagram by three years. It is marked as grey shaded region in Fig. 1. We note that four new points beyond the last epoch in Nasiroglu *et al.* (2017), i.e. November 3rd, 2016, fit the earlier third-body model very well. The fitting model (red curve in Fig. 1) indicates that the observed quasi-periodic (O-C) variability can be explained by the presence of a brown dwarf with the minimal mass of 15 Jupiter masses, orbiting the binary with the period of about 10 years.

Table 1. List of four new NSVS 14256825 eclipse times after November 3th, 2016.

Cycle	BJD	Error [days]	Ecl.Type	Telescope
31004.0	2457696.247527740	0.000012891	1	ADYU60
31212.0	2457719.205340000	0.000007616	1	TUG
32556.0	2457867.548033890	0.000012688	1	TUG
32773.0	2457891.499207930	0.000021861	1	ADYU60

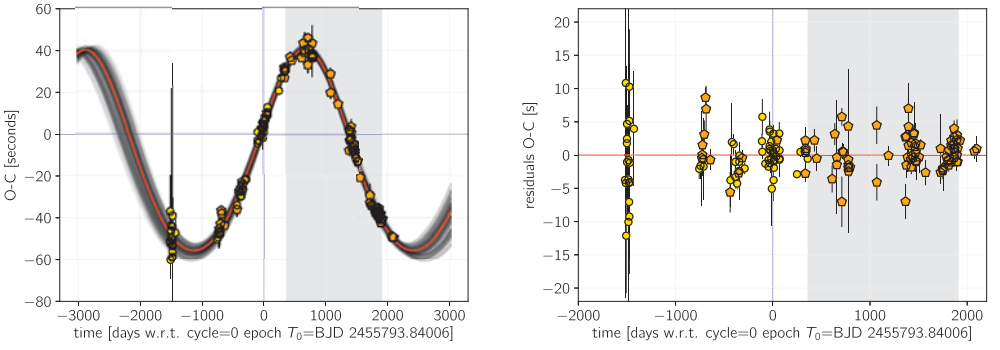

Figure 1. *The left panel:* the synthetic curve of the best-fitting model (red curve) to all data overplotted on 100 sample models from the MCMC posterior. Filled circles are for data in the up-to date literature and darker pentagons are for the new measurements presented in Nasiroglu *et al.* (2017), which contributed new data within the shaded box, and in this paper (after cycle number of 2000, see Tab. 1). *The right panel:* residuals to the best-fitting model.

A few compact, post-common envelope binaries exhibit similar, quasi-periodic variations of the (O-C) attributed to low-mass companions, out of which many are still uncertain. The GAIA mission has a great potential to confirm or dismiss the presence of such bodies. The eclipse timing will be useful to constrain astrometric models and to explain the nature of their observed (O-C) diagrams. Therefore we continue to monitor a sample of such binaries.

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