STUDY AND ANALYSIS OF THE NEW ECLIPSING PCEB SYSTEM: SDSS J074548.63+263123.4

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ABSTRACT

The common envelope process is known as one complicated phase in binary evolution. A lot of efforts have been dedicated to study this common envelope stage, but many questions related to this process are yet to be answered. If one binary survives the common envelope, the binary will emerge as a white dwarf accompanied by low mass main sequence star in close orbit, or often referred as the Post Common Envelope Binary (PCEB). SDSS J074548.63+263123.4 is among the list of the newly found PCEB from the Sloan Digital Sky Survey (SDSS). This star is proposed to be a strong eclipsing system candidate due to the ellipsoidal modulation in its light curve. In this work, we aim to confirm the eclipsing nature of SDSS J074548.63+263123.4 and to determine the stellar and orbital parameters using the software Binary Maker 3.0. We detected the primary eclipse in the light curve of SDSS J074548.63+263123.4 from our follow up observation since January 2014 by using the ULTRASPEC instrument from the Thai National Observatory. The data obtained on 7th January 2014 in *g'* filter show an evident drop in brightness during the eclipse of the white dwarf, while this eclipse is less prominent in the data taken in the next night using clear filter. In the end of 2014, SDSS J074548.63+263123.4 was observed on various filters (*r'*, *g'* and KG5 filters). All of observation shown primary eclipse and we can confirm completely that SDSS J074548.63+263123.4 is eclipsing binaries system.

1. INTRODUCTION

The light points in the night sky that we call stars can be divided into two categories. There are truly single star and also pair or multiple stars. In this work we focus on pair of stars or binary star in Post Common Envelope (PCE), which two components moving about their common center of mass. PCE is one of phase in evolution of binary star this phase is exist after transferring mass from massive star to another due to massive star expand over its Roche Lobe. The two stars then orbit inside a Common Envelope (CE)[1]. Orbital energy and angular momentum are extracted from the binary orbit and lead to the ejection of the envelope, exposing a Post Common Envelope Binary (PCEB). Usually PCEB contain with Main sequence star and white dwarf.

SDSS J0745+2631 was discovered by Parson et al 2013[2], who observed several new eclipsing binary stars by using Sloan Digital Sky Survey (SDSS) and Catalina Sky Survey (CSS). SDSS J0745+2631 was one in amount of them which observed with *r'* filter.

The observation of SDSS J0745+2531 were performed on 7th January 2014 and 20th - 22nd December 2014 by using Thai National Telescope (TNT) 2.4m with ULTRASPEC in *g'*, *r'*, and KG5 filters. The aim of this work are study and analysis SDSS J0745+2631. The photometry was performed by using Image Reduction Analysis Facility (IRAF). The primary clearly from observation in *g'* filter. In term of modeling we used Binary Maker 3.0 (BM 3.0) to determine the physical parameters and geometries of this system.

2.OBSERVATION

Table 1. Plan of Observation

Date	Filter	Time of observation (UT)	Exposure time (S)
7 Jan 2014	*g'*	16:30 – 20:00	8.942
20 Dec 2014	*r'*	18:08 – 23:03	9.824
22 Dec 2014	KG5	14:30 – 17:04	8.374
22 Dec 2014	*g'*	20:32 – 21:37	3.352

We observed SDSS J0745+2631 in two times, first on 7th January 2014 and second on 20th-22nd December 2014 at Thai National Observatory (TNO), Doi Inthanon, Chiang Mai, Thailand by using 2.4 meter Telescope with ULTRASPEC (*g' r'* and kg5 filters).

3. DATA ANALYSIS

3.1 Photometry : IRAF

Figure 1. IRAF Processing

3.2 Photometry : ULTRASPEC

3.3 Modeling: Binary Maker 3.0

- **Modeling of Eclipsing Binary: SDSS J0745 +2631**

4. RESULT

From the modeling with BM 3.0 the fit of theoretical light curve and surface outline are shown in Figure 2 and Figure 3 respectively. The good of fitness in this modeling was confirmed by chi-square value equal to 0.087351.

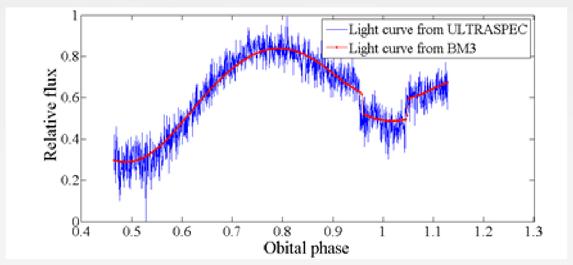

Figure 2. The light curve of SDSS J0745+2631 observed with *g'* filter (blue line) overlaid with theoretical light curve (red line).

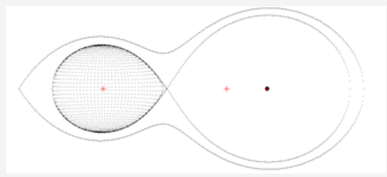

Figure 3. The surface outline of SDSS J0745+2631 from modeling by BM 3.0.

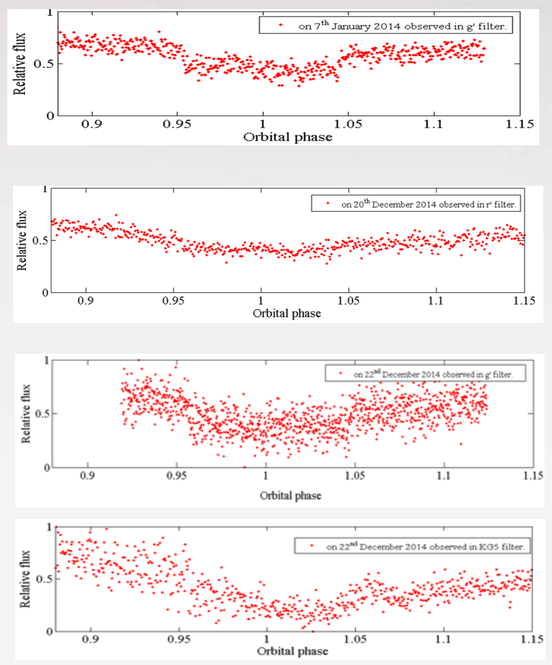

Figure 4. Light curves of SDSS J0745+2631 from TNT with ULTRASPEC on 7th January 2014 (*g'* filter), on 20th December 2014 (*r'* filter), and 22nd December 2014 (*g'* and KG5 filters). Unfortunately, the sky conditions was not favorable. Thus, the large scatter on the data points due to bad seeing.

Table 2. Input parameters for modeling by BM 3.0.

Binary system	period	Temperature of white dwarf	Temperature of main sequence	Radius (back)	*Mass ratio
SDSS J0745+2631	0.219 day	9000K	3666K	0.310R⊙	0.330

$$* \text{ mass ratio} = \frac{\text{mass of main sequence}}{\text{mass of white dwarf}}$$

Table 3. Spot parameter for modeling by BM 3.0.

Number of spot	Spot co-latitude1 (°)	Spot longitude1 (°)	Spot radius1 (°)	Spot factor
1	60.000	0.000	40	0.1
2	120.000	0.000	40	0.1
3	90	150	25	0.9
4	90	80	30	1.010
5	90	40	40	0.1

5. CONCLUSION

As we observed SDSS J0745+2631 by using TNT with ULTRASPEC in *g'*, *r'* and KG5 filters we are able to confirmed that SDSS J0745+2531 is post common envelope binary system which consist main sequence and white dwarf. Light curves of SDSS J0745+2631 showing large ellipsoidal modulation, implying that the main sequence star is close to filling its Roche lobe. The temperature and radius of main sequence star are 3666K and 0.3100$R_{\odot}$, respectively. There are many star spots on main sequence star by modeling by using BM 3.0. The temperature and radius of white dwarf are 9000K and 0.0103$R_{\odot}$, respectively.

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