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A comprehensive study of the sdB+dM binary TYC 3315-1807-1

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Abstract. TYC 3315-1807-1 is an sdB+dM binary first reported by Kawka et al. (2010). Archival photometric data indicate the presence of a secondary companion causing a large reflection effect. Spectroscopic observations of the object were carried out from Vainu Bappu Observatory, Kavalur, to probe the nature of the secondary companion and to understand the post common-envelope evolution of such objects. Spectral line equivalent widths (EW) exhibit orbital phase dependent variations, indicating the probable contribution from the secondary. A period variation study of the object was carried out using times of minima obtained from the literature and suggesting a decrease in period. The evolutionary state of the system is evaluated and discussed.

Key words: binaries: subdwarfs – binaries: period variation – stars: spectroscopy: Balmer lines – stars: spectroscopy: equivalent widths

1. Introduction

Subdwarf (sdB) stars are core helium burning stars with a very thin hydrogen envelope. They lie on the Extreme Horizontal Branch (EHB) and a significant fraction are close binary systems (Morales-Rueda et al., 2003; Maxted et al., 2001). The object TYC 3315-1807-1 (03h21m39.62s, $+47°27'18\farcs79$) is listed in the MUCHFUSS catalogue of subdwarfs (Kupfer et al., 2015). Kawka et al. (2010) classified the system as a sdB+dM binary. Phase resolved spectroscopy may help to understand the nature of the companion, so an attempt was made to obtain low-resolution spectroscopic observations at various phases.

2. Period Variation from Archival Data

A total of 4575 V band data points with a mean photometric error of ~ 0.01 mag were collected from SuperWASP archives. A Python code was run to sift through the data to find local light curve minima. After searching for contiguous blocks of data near the minima, a SciPy curve fitting routine was used to make Gaussian fits to the data and determine the minima (HJD_0). We obtained a total of 10 times of minima. The O-C values are calculated by using the linear ephemeris $\mathrm{Min\,I} = 2455045.5820 + 0.2658519 \times E$. The O-C diagram shows a

decreasing parabolic trend corresponding to a period decrease $\frac{dP}{dt}$ of -1.81733×10^{-5} days/yr.

3. Observations

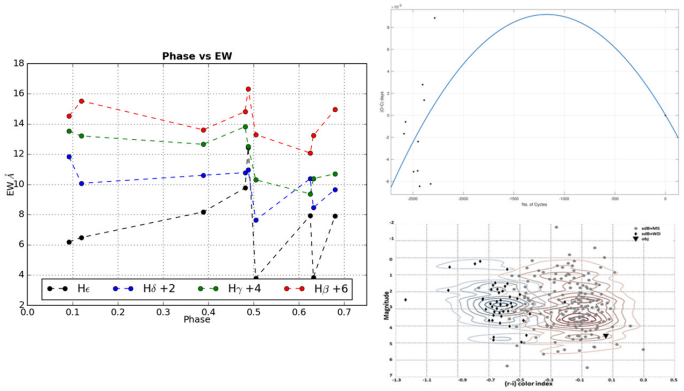

Figure 1. Left panel: Balmer lines equivalent width vs. phase. Upper right panel: O-C diagram for studying the period variation. Lower right panel: magnitude vs. $r-i$ color for sdB+MS (left contour) and sdB+WD (right contour) systems. The inverted triangle shows the position of TYC 3315-1807-1.

Spectroscopic data were obtained using the 2.3-m telescope at Vainu Bappu Observatory, India, during 3 nights of January 2019. Nine low-resolution spectra were obtained at 6.7 Å per pixel. The spectra were centered around the Hβ line at 4800 Å.

4. Discussion and Results

The Balmer lines EW (Fig. 1) derived from the spectroscopic observations show phase dependent variation. The O-C diagram (Fig. 1) indicates a decreasing trend in the period at a rate of $\frac{dP}{dt} = -1.81733 \times 10^{-5}$ days/yr. Fig. 1 also shows a color magnitude diagram of known sdB+dM systems, with two different contours representing the location of sdB+Main-Sequence and sdB+White-Dwarf systems, respectively. It is observed that TYC 3315-1807-1 (inverted triangle) is located within the sdB+MS area.

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