# PHOTOMETRY OF BD -7° 3007

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ABSTRACT. Photometric observations of BD -7° 3007 in B and V filters are reported. Rapid flickering appears to be present at all phases, implying an unfavourable angle of inclination of orbit for seeing eclipse effects. A modulation of the light curve of period about an hour is present only on one night. The continuum energy distribution agrees with that of β Com (GO V) in the longer wavelength region only.

## 1. INTRODUCTION

BD -7° 3007 ( ≡ RW Sextantis) is classified into the subgroup of novalike binaries. It is relatively bright member of this subgroup ( $m_V = 9.3$). The classification is based on the spectral features which bear resemblance to UX UMa, the prototype. Photometric studies by Hesser et al., (1972) showed low amplitude variability on time scales of 600 to 1200 seconds, while the eclipse effects were not detectable. Spectroscopic studies by Cowley et al., (1977) showed radial velocity variations matching with a period of about 6 hours.

The most recent study of this system is by Greenstein and Oke (1982) in the optical and UV regions. For $\lambda > 5000$, a blackbody near 7000°K could be matched, but at shorter wavelengths the continuous spectrum could be represented by an accretion disc. They also report strongly displaced absorptions.

The present photometric study was taken up to search for short and long term variations of light, which are likely to yield information on the orbital parameters. The spectrophotometric observation supplements these results in understanding the nature of the secondary.

## 2. OBSERVATIONS

All the observations, reported here, were done at the 102 cm reflector of the Vainu Bappu Observatory, Kavalur, during 1979-80. A single channel photometer equipped with a refrigerated photomultiplier EMI9558B was used, with the help of an online computer. The integration time was always chosen to be one second and the observations were limited the standard B and V filters, of the Johnson and Morgan system (1953). On any night,

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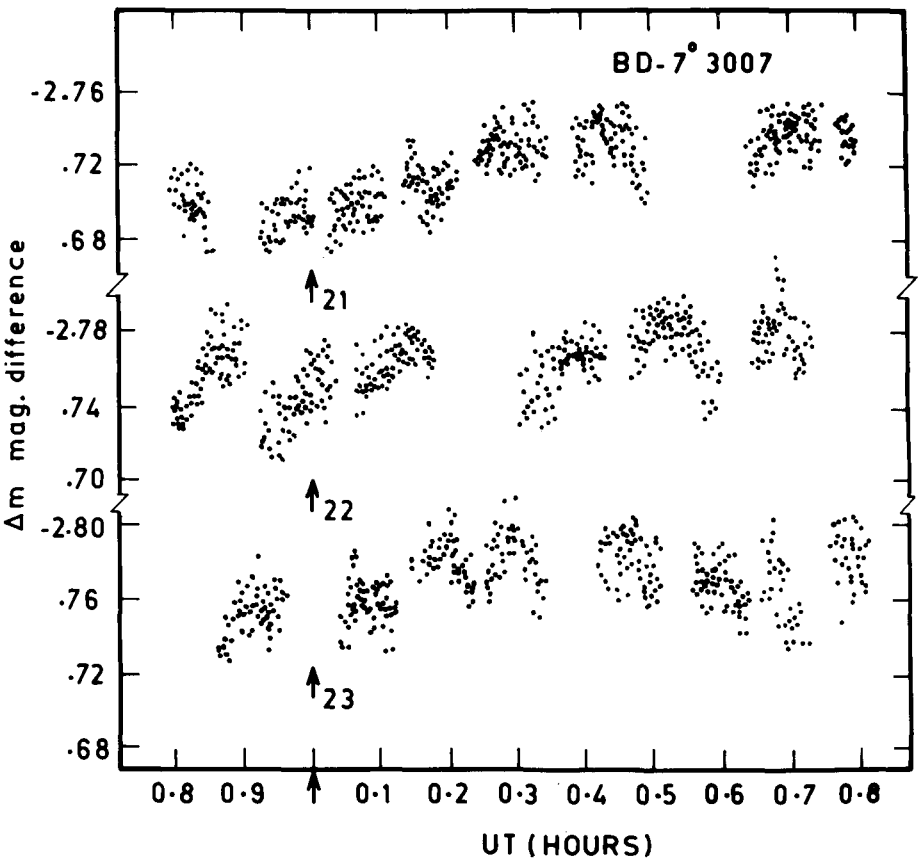


Figure 1 : The V magnitude variation of BD -7° 3007 on 26th January 1980. The abcissa is graduated in fractions of an hour and the hour is indicated by arrow.

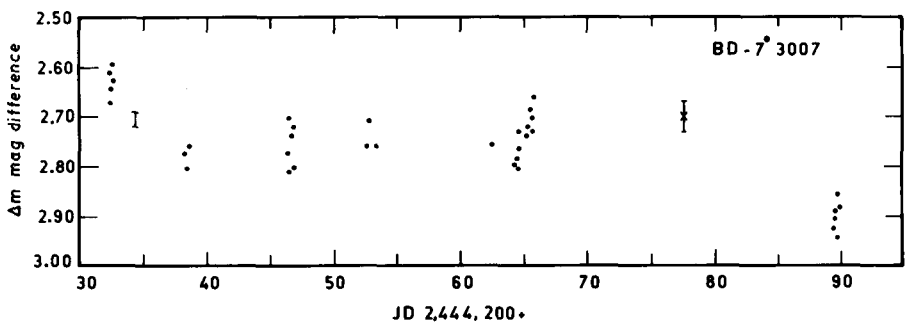


Figure 2: Long term variation of BD -7° 3007. The cross corresponds to the observation with 38 cm telescope.

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a few points were recorded with both the filters; but generally the entire night was devoted to continuous monitoring in one filter only. A 9 arcsec diaphragm was used to minimize the sky background.

The neighbouring star BD -7° 3005 (KO, $m_v$ = 8.6) was used as a comparison, while another star BD -8° 2897 (F2, $m_v$ = 6.3) was occassionally used for checking the system. The data consist of continuous runs for 10 min (at very low hour angles this was restricted to 5 min) with intervening runs of comparison star and sky monitor. Each such run was subjected to power spectrum analysis by Direct Fourier Transform techniques (Blackmann and Tukey, 1958) after prewhitening. The number of lags were limited to one-fifth the total number of points. This limits the detectable periods to 100s on longer runs and 50s on shorter ones. This analysis showed a range of periodicities from 15s to 25s existed for all runs and the amplitude was generally about $0^m.08$.

In order to look for a longer term variation, the data points were averaged for 5s. Any possible periodicity was searched for by the method described by Raveendran et al. (1982). No meaningful periodicities were immediately apparent in the range 1 to 10 hours. However, only on one occasion, it appeared that some kind of a modulation was present. This data of 26th Jan. 1980 is represented in Figure 1. Here the abscissa is graduated in fractions of an hour and 21, 22 and 23 hours U.T. are indicated by arrows. At these points it appears as though there is a decrease in the light level. Such an effect was not seen on any other night. The long term variations are represented in Figure 2. On 24th Dec 1979 it looked brighter than other days. The variations within the night are sometimes $0^m.1$ magnitude. The Figure includes one observation made with the 38 cm telescope with an uncooled 1P 21 detector and DC mode of recording. On 19th Feb 1980, it appeared that BD -7° 3005 (the comparison star) had brightened by about $0^m.15$ magnitude. Allowing for this apparent decrease of light for BD -7° 3007, it appears that the light variation is irregular.

The spectrophotometric observations were done using the automated spectrum scanner (Bappu, 1977), with a resolution of 20Å per channel in two parts. $\xi^2$ Cet, 109 Vir and β Com were the standards used. The integration was done over 44 scans (a total of 22 seconds per channel). The energy distribution looks very noisy (Figure 3), in spite of the three point averaging of the data. Emissions at $H_\gamma$ and $H_\beta$ are just detectable, while at $H_\alpha$ this is not possible. There is a small dip near λ = 6150, which is barely recognizable. The energy distribution matches with that of β Com better in the red region than in the blue.

## 3. DISCUSSION

The spectrum of BD -7° 3007 has been studied in great detail by Cowley and MacConnell (1972). The presence of HeI and CaII lines, along with broad absorptions of H, have been pointed out. A similar phenomenon was noticed in case of CD -42° 14462 (V3885 Sgr) also. Hesser et al.(1972) found that the energy distribution of BD -7° 3007 agrees with that of a blackbody of 12000°K. Since no single white dwarf is known to exhibit lines of HeI, CaII and H, they suspected the binary nature.

Further detailed study by Cowley et al. (1977) indicated a radial

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velocity variation with period about 0.25d. Since the nature of the companion could not be established, they derived the masses of the components based on the small value of the mass function. Thus a late type secondary and a white dwarf, each of mass $1M_0$, constitute this binary. Hesser et al. (1972) had indicated a possibility of both components being degenerate. But Greenstein and Oke (1982) found that for $\lambda > 5000$, the energy distribution agrees with that of a blackbody of 7000°K. They assumed that the secondary is of spectral type F and derived a distance of 400pc. The masses derived by Cowley et al. (1977) assumes a mass of the white dwarf to be $1M_0$. From the period - mass ratio relation of Warner (1973), one can derive a mass ratio of 0.76 for this system. Based on a study of the mass distribution of novalike subgroup members (Shylaja, 1986), it is found that the mass of the primary is smaller in these systems. Therefore, we may start with smaller masses of the white dwarf. A range of $0.65M_0$ to $1M_0$ for the white dwarf gives a corresponding range of the mass of the secondary as $0.85M_0$ to $1.3M_0$. This sets the spectral type of the secondary to G or later, which is expected to show the TiO bands, as was seen in case of CD -42° 14462 (Haug and Drechsel, 1985). It is interesting to note that there is an indication of a dip near 6150A (Figure 3), which may be due to the TiOband. This can be confirmed only by high dispersion spectrum.

Although the irregular variation of light (Figures 1 and 2) have been noted by previous investigators, the modulation of about one hour is not reported yet in any member of this subgroup of novalike binaries. This kind of phenomenon was observed in case of EX Hya (Vogt et al., 1980; Shylaja, 1985), which belongs to a different group of cataclysmic variables. It has also been established by Cowley et al. (1977), that the photometric variations are not due to orbital effects, similar to the case of CD -42° 14462. Therefore other mechanisms like small changes in mass transfer rate of variations in emission line strength will have to be considered to explain this type of modulation. As it has already been reported earlier, small variations in emission line strengths are not uncommon in this subgroup. Further, this subgroup is associated with small rates of mass transfer and any small change may become quite noticeable. Under these circumstances simultaneous spectroscopic studies are strongly suggested for a better understanding of this phenomenon.

The evolutionary status of the novalike binaries and their relation to other groups of cataclysmic variables are still being debated about. In this connection, the similarity found by Greenstein and Oke (1982) of BD -7° 3007 to the standstills ofZ Cam group of variables as well as to the slow nova HR Delphini may be mentioned. Warner (1985) has argued that it is likely that many nova like binaries are nova remnants. Therefore, only future detailed investigations can provide clues on whether BD -7° 3007 is a slow nova, or a Z Cam variable at standstill, or a quiescent nova, or even an ultra short period cataclysmic binary like EX Hya.

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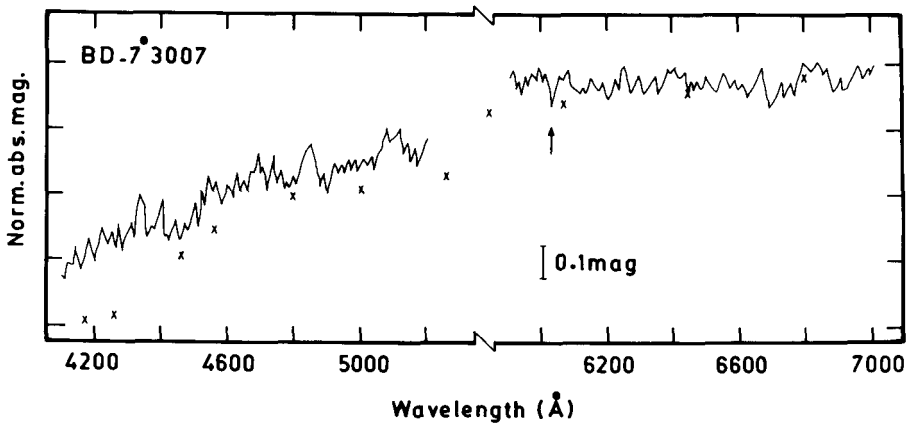


Figure 3 : The continuum energy distribution of BD -7° 3007. The crosses correspond to β Com (G0V). The blue and red parts have been normalized separately and combined with the help of βCom.

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