A NEW B-SUBDWARF ECLIPSING BINARY WITH AN EXTREMELY SHORT PERIOD

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ABSTRACT. The B-type Subdwarf BD-07° 3477 has been found to be an eclipsing binary with a period of about 2^h48^m. A preliminary analysis of the light curve reveals the system to be fully detached. It appears to be similar in many respects to the O-Subdwarf binary AA Dor which is thought to be the remnant of a system which has undergone a common envelope phase of evolution.

1. INTRODUCTION

During a UBV Survey of UV-bright objects from the S2/68 catalogue (Carnochan and Wilson, 1983) we found BD-07° 3477 (α 1241.8, δ - 0824 (1950)) to be an eclipsing variable. This star has been classified as a possible B subdwarf by Berger and Fringant (1980).

2. ANALYSIS

(a) Period
From 27 primary minima covering an interval of 493 days, we find the following ephemeris:-

HJD (primary minimum) = 2445730.556057 + 0.116719651.n
$\pm$.000017 $\pm$.0000000098

The remarkably short period (2^h48^m) is only slightly longer than that found for the central star of Abell 41 (2^h43^m) by Grauer and Bond (1983).

b) Velocity Curve
The star is a single-lined spectroscopic binary and from the spectra we have derived the following parameters:-

k_1 = 87.9 $\pm$ 4.8 km/sec γ = -12.5 $\pm$ 3.6 km/sec
$a_1 \sin i$ = 1.41 x 10^5 ($\pm$ .08 x 10^5) km f(M) = 0.0082 $\pm$ .0013 Mo
= 0.20 R_O

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c) Light Curve

The best UBV(RI)$_C$ light curves available to us were used for analysis. All observations were made with the 0.5m or 1.0m telescopes in Sutherland. Neither eclipse is total, and there is clearly a very pronounced reflection effect.

An exploratory investigation revealed that the inclination of the system is high, that both stars must have high gravities for any reasonable value of the mass ratio and that the secondary contributes very little light except through the reflection effect. We used the parameters determined from this simple analysis as starting values for the Wilson-Devinney differential correction program. The temperature of the primary was set at 26000K on the basis of the UBV colours and the Q-θ relation of Greenstein and Sargent (1974) for high gravity objects. Theoretical limb darkening coefficients were used for the hot star, while for the secondary it was found necessary to use a value of 1.0 for all colours. A geometric albedo of 1.0 was used for the secondary. We found T_2 = 4500K to give a reasonably good fit though this may be uncertain by ± 500K or more. Photometry in the infrared is needed before a satisfactory temperature can be found for the secondary.

A solution was performed for all 5 light curves simultaneously, so that the parameters that were derived are the best compromise. This resulted in polar radii (in units of the separation) of r_1 = 0.203 and r_2 = 0.207.

A plausible combination of masses is found to be m_1 = 0.25 $M_\odot$ and m_2 = 0.12 $M_\odot$ in which case the primary could be a hydrogen shell burning star with a degenerate core while the secondary could lie on the lower zero age main sequence. The system could have passed through a common envelope stage of evolution when the primary became a red giant, and then have lost a substantial fraction of its mass. This is the model proposed for the O-subdwarf binary AA Dor by Paczynski (1980), though in that case the primary is hotter and the secondary less massive than in BD-07° 3477. Other similar objects in a different evolutionary stage may be the central star of Abell 41 and UU Sge.

Since BD-07° 3477 is so relatively bright, it might be possible to see evidence of the secondary in high dispersion spectra. Infrared photometry would be useful in determining the secondary temperature.

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