COMMISSION 27 OF THE I. A. U.
INFORMATION BULLETIN ON VARIABLE STARS
Number 3571

Konkoly Observatory
Budapest
8 March 1991

HU ISSN 0374 - 0676

WR 22 is an eclipsing binary star

Introduction

WR 22 (≡ HD 92740 ≡ V429 Car) is a bright ($V \sim 6.4$) Wolf-Rayet star of spectral type WN7, member of the Car OB1 association (Lundström and Stenholm, 1984). For a long time, it has been known to exhibit a composite spectrum (Smith, 1955; Underhill, 1968) in the sense that weak absorption lines (e.g. Balmer series from H7 up to H12) are observed in a spectrum that is otherwise characterized by typical strong Wolf-Rayet emission lines. These characteristics which are usually suggestive of binarity, were the motivation for Niemela (1973) to undertake a radial velocity study. Her preliminary study confirmed the binary nature of WR 22 but the absorption and emission lines were found to move in phase, indicating that they are formed in the same object. Subsequent spectroscopic investigations (Niemela, 1979; Moffat and Seggewiss, 1978; Conti, Niemela and Walborn, 1979) led to a revision of the period and to a rather well-determined set of orbital parameters: let us just mention a period of 80.35 days, a high eccentricity $e \sim 0.55$ and a longitude of the periastron ω of roughly 275°. Up to now, no marked trace of the secondary star was found, and the star is therefore classified as an SB1.

WR 22, as most Wolf-Rayet stars, is photometrically variable. On JD 2,447,235.5, during a campaign on the intrinsic variability of several WR stars, Balona et al. (1989a, b) observed a dip in the lightcurve of WR 22 of about 0.1 mag in the Johnson B filter. The fading was interpreted as the signature of an eclipse. It lasted roughly one day, or less, and corresponded to the Wolf-Rayet hiding the secondary star. As the star is known to vary on a short timescale, and as sporadic events are always a possibility (Shylaya, 1991), we decided to search for another occurence of the suspected eclipse in order to confirm the interpretation of Balona et al. (1989a, b).

Observations

WR 22 has been frequently observed together with two comparison stars (HD 96287 and HD 96568), in the framework of the Long-Term Photometry of Variables project (LTPV, Sterken, 1983) at the European Southern Observatory (ESO, La Silla, Chile), with the Danish 50cm telescope equipped with the four-channel Strömgren photometer. In addition, during 1989-1990, the Liège team organized a campaign of observations on that particular star. High S/N high-resolution spectroscopic data have been acquired and will be the subject of a forthcoming publication. An intensive two-site (South Africa and Chile) photometric campaign was also set up in order to investigate the

variability of both WR 40 and WR 22; we managed to get one observing run around the predicted eclipse position, but unfortunately, no data from South Africa were obtained at that crucial date. To remain consistent with the LTPV data, the ESO photometric data of the campaign were also taken at the Danish 50cm telescope. The integration time was typically 3 × 20s and WR 22 was observed approximately every ten to twenty minutes during entire nights.

Results

From an inspection of the LTPV data, we noticed that the discovery eclipse had also been observed at ESO, the minimum brightness being observed around JD 2,447,235.8. But the intrinsic variability of WR 22 prevents us from measuring the exact position on the basis of a unique eclipse. A second eclipse was observed on JD 2,447,476.83 (three cycles later) but only two measurements were obtained that night. Finally, a third eclipse was observed during our intensive campaign. The corresponding part of the lightcurve of WR 22 in the Strömgren *b* filter is given in figure 1. Clearly the brightness is low from JD 2,447,958.608 to JD 2,447,958.713, and, thereafter, it starts to increase. This corresponds to nine cycles after the discovery eclipse. The relative positions of the eclipses are in rather good agreement with the published period. These results definitively confirm the eclipsing binary nature of WR 22.

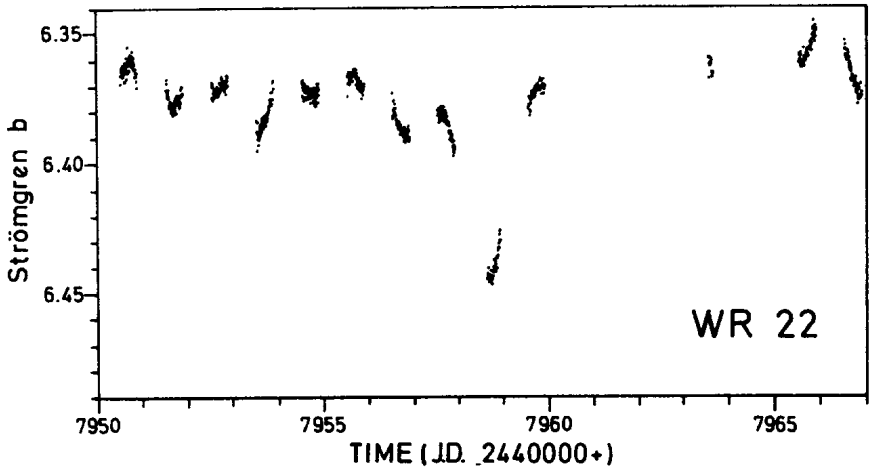

Figure 1: The lightcurve of WR 22 in the Strömgren *b* filter. The eclipse around JD 2,447,958.6 is clearly visible.

It seems that the eclipse is less deep in Strömgren filters than in the Johnson *B* one. The star changes colours during the eclipse. The magnitude and colour differences inside-eclipse *minus* outside-eclipse are

$$\Delta b = 0.071$$
$$\Delta(b-y) = -0.012$$
$$\Delta m_1 = 0.023$$
$$\Delta c_1 = -0.014\ .$$

Due to the intrinsic variability of WR 22 (clearly visible in figure 1), the above values are expected to bear a standard deviation of roughly 0.005 mag. Nothing can be said about the true nature of the eclipse (total, transit, partial...). More observations are needed in order to have a better phase coverage and to have better statistics on the intrinsic variability of WR 22 with the aim of determining the shape of the eclipses.

We searched the literature for other occurences of the eclipse; we found no observation made at the right time with the exception of the polarimetric measurements of Drissen et al. (1987). No change is visible in the polarimetry.

We folded our data in a phase diagram in order to search for the other eclipse (Wolf-Rayet behind) of the system. Despite good coverage we found no trace of such an eclipse. This result is in good agreement with the observations of Moffat and Seggewiss (1978). No other adequate measurements are available in the literature.

The inclination of the system is therefore such that the eclipse with the Wolf-Rayet in front and near the periastron is visible, whereas the eclipse near the apoastron is at best marginal (because possibly hidden by the variability of the Wolf-Rayet). Although quite possible, this puts severe constraints on the inclination i of the orbital plane. The value of i will be discussed elsewhere, together with all the other newly redetermined orbital parameters.

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