Narrow-band photometry of the eclipsing WN7+O binary WR22

Pierre Royer¹, Gregor Rauw¹, Jean Manfroid¹, Eric Gosset¹, and Jean-Marie Vreux
Institut d’Astrophysique et de Géophysique, Université de Liège, 5, Avenue de Cointe, B-4000 Liège, Belgium

Abstract. In the present paper, we discuss photometric observations of the February 1996 eclipse of the very massive WR+O binary WR22. Our data were obtained with a set of narrow-band filters, specially designed for the study of WR stars.

1. Introduction

The WN7+abs+O binary WR 22 (Porb = 80.3 d) displays a shallow eclipse around its periastron passage, when the WR star is in front of its companion (Balona et al. 1989; Gosset et al. 1991). Such an atmospheric eclipse results from the phase-dependent opacity along our sightline towards the O star and is a common feature among WR+O binaries with orbital periods shorter than 30 days (Lamontagne et al. 1996).

In the case of WR22, as a result of the combination of the inclination of the orbit, of its eccentricity (e ~ 0.56), and of the argument of the periastron (ω ~ 272°), only the secondary eclipse near periastron is present, whereas no occultation is observed near apastron (Gosset et al. 1991; Rauw et al. 1996).

2. Narrow-band photometry of WR 22

Photometric observations, through specially designed narrow-band filters, of the secondary eclipse of WR 22 were acquired during five nights in February 1996 (JD 2450125–129) at the Bochum 0.6 m telescope (La Silla, Chile) equipped with the DLR CCD camera using a Tektronix 1024×1024 chip (pixel size 23 μm). For a detailed description of the characteristics and performances of our set of narrow-band filters, see Royer et al. (1998). The data were reduced using the algorithm described by Manfroid (1993).

Given the incomplete phase-coverage of the eclipse by the narrow-band observations, we have fitted the data with the mean light-curve, as derived from a more extensive data set obtained in the Strömgren y filter, keeping the depth of the eclipse as the only free parameter (see Fig. 1). The Strömgren data set will be discussed and analysed in a forthcoming paper (Rauw et al. in preparation).

¹At the Fonds National de la Recherche Scientifique, Belgium
Figure 1. Light-curve of WR 22 as observed with a filter centered on 6051 Å. Differential magnitudes are shown as a function of $\theta = \psi - \frac{3\pi}{2} + \omega$ where $\psi$ is the true anomaly and $\omega$ the argument of the periastron (orbital elements from Rauw et al. 1996).

As expected, the eclipse as observed with the filter centered on the He II $\lambda$4686 emission line is shallower than with the continuum filters (centered on $\lambda$5057 and $\lambda$6051). The fitted depths are $\Delta m(\lambda 4686) = 0.062$, $\Delta m(\lambda 5057) = 0.112$ and $\Delta m(\lambda 6051) = 0.102$. The depths of the eclipse in the continuum filters provide upper limits on the luminosity ratio $L_{\text{WR}}/L_0$ of 9.2 ($\lambda$5057) and 10.1 ($\lambda$6051). We have performed numerical simulations to quantify the contribution of the He II $\lambda$4686 line to the integrated flux in the narrow filter as a function of the line’s orbital Doppler shift. On the average, the emission line contributes for some 42% of the total flux and hence accounts for the depth difference of the eclipse as observed with the He II $\lambda$4686 filter compared to the continuum filters. During the phase interval $\phi = 0.97 \rightarrow 0.03$, the radial velocity of the He II $\lambda$4686 line increases from $\sim 0$ to $\sim +120 \text{ km s}^{-1}$. Due to the Doppler shift of the line within the narrow filter passband, our simulations, accordingly, yield an apparent faintening by 0.007 magnitude during this phase interval, i.e., too small an effect to be detected in our data given their accuracy and the intrinsic variability of the WN7+abs star. In contrast to most of the light-curves of eclipsing WR+O systems reported by Lamontagne et al. (1996), the light-curve of WR 22 displays a rather narrow shape without prominent extended wings, pointing towards a rather low mass-loss rate ($\log M \leq -4.8$, Rauw 1997).

References

Balona, L.A., Egan, J., Marang, F. 1989, MNRAS 240, 103

Gosset, E., Remy, M., Manfroid, J., et al. 1991, IBVS 3571

Lamontagne, R., Moffat, A.F.J., Drissen, L., Robert, C., Matthews, J.M. 1996, AJ 112, 2227

Manfroid, J. 1993, A&A 271, 714

Rauw, G. 1997, PhD Thesis, Université de Liège

Rauw, G., Vreux, J.-M., Gosset, E., et al. 1996, A&A 306, 771

Royer, P., Vreux, J.-M., Manfroid, J. 1998, A&AS 130, 407