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OPTICAL LIGHT VARIABILITY OF LS 3074

We report detection of optical light variations of LS 3074, a luminous object in the southern coal-sack zone (Marraco and Orsatti, 1982).

Morrell and Niemela (1990) discovered its binary nature and derived preliminary orbital elements based on the velocity curves of both components which were classified as O4f+ and O6-7(:). The very low values of $M \times \sin^3 i$ for both components (8 and 9 $M_\odot$, later on corrected to 9.5 and 10 $M_\odot$ by Niemela et al. (1992) would imply a low inclination of the system. But trying to determine the inclination by means of linear polarization measurements Niemela et al. (1992) derived a value of 75°. This is by far too high to put the masses at the expected level about 20-30 $M_\odot$ (Herrero et al., 1992). That procedure of fixing the inclination was questioned by the authors themselves because it could be affected by additional polarization in the system.

Since empirical masses of early O type stars are very poorly known it seemed worthwile to look for photometric variations of LS 3074 to possibly get a better estimate of the inclination. During an observing stay at the ESO Observatory La Silla/Chile at the beginning of April 1991 some UBVRI measurements could be obtained using the standard single-channel photometer at the ESO 50 cm telescope. Folding the data with the spectroscopic period (P=2.185 d) given by Niemela et al. (1992) clearly revealed ellipsoidal variations. Figure 1 shows the resulting V light curve with a full amplitude of about 0.15 mag. Open squares represent measurements obtained under less favourable weather conditions. Their estimated error amounts to about 0.04 mag whereas the error of the more reliable measurements (filled squares) is around 0.02 mag. For comparison with UBV values compiled by Marraco and Orsatti (1982) we give here colours measured at V=11.74 (11.73): B−V=1.13 (1.17), U−B=−0.10 (−0.10), V−R=0.81, V−I=1.59 (data by Marraco and Orsatti in brackets). The values are affected by the strong reddening towards the coal-sack region.

Preliminary photometric elements were determined using the GRADUS-code (Simon et al., 1994), a light curve synthesis program which employs Roche geometry and allows a careful treatment of heating and scattering effects. Instead of a limb darkening law the angular distribution of radiation generated by non-LTE model atmospheres is applied. With the fixed temperature of 46 000K for the O4f+ star and 40 000K for the O6-7 star (Kudritzki and Hummer, 1990), and with the fixed spectroscopic parameters (radial velocity amplitudes (222 and 218 km/s) and $M \times \sin^3 i$) we found reliable light curve fits for inclinations around 50°. This yielded (nearly identical) masses for both components around 20-21 $M_\odot$ and polar radii around 8.7-8.8 $R_\odot$. With these parameters LS 3074 constitutes a contact system. Increasing the inclination results in a synthetic light curve showing first evidence for a grazing eclipse which cannot be recognized in the present photometric data. Nevertheless, this might unveil itself in high quality measurements. The fit for e.g. an inclination of 55°is still acceptable (but worse than that for 50°) so

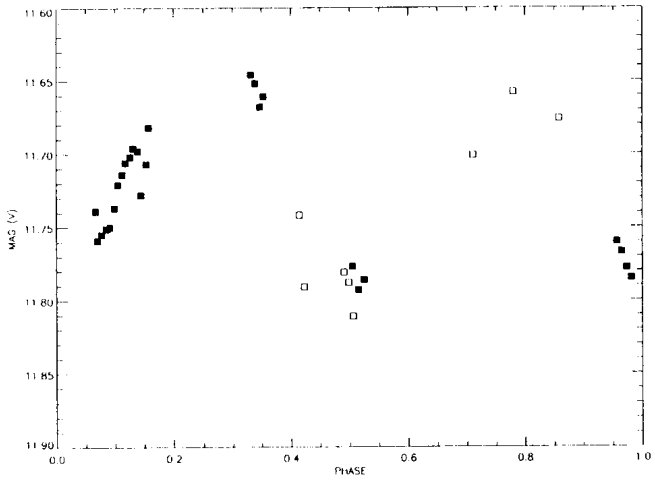

Figure 1. V light curve of LS 3074. Phases were calculated according to the ephemeris HJD 244 8348.619+2^{d}.185×E. For further explanation see text.

that at present no clear decision can be made. The corresponding parameters are: 17-18 $M_{\odot}$, 7.6-8.3 $R_{\odot}$, semidetached system. For inclinations below 50° no acceptable fit to the light curve could be found. We conclude that inclinations between 50° and 55° represent best the spectroscopic and photometric measurements available at the moment thus restricting the masses of LS 3074 to about 17-21 $M_{\odot}$. This result is in line with the masses for galactic O stars derived from spectroscopic analysis by Herrero et al. (1992) which are systematically lower than those obtained from evolutionary calculations.

Better spectroscopic (spectral types, radial velocity amplitudes) as well as photometric (grazing eclipse) data is needed to analyse this system with the high accuracy appropriate to the importance of the problem in question.

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