PHOTOMETRY OF RZ OPHIUCHI - AN INTERNATIONAL COLLABORATION

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ABSTRACT. UBV observations, plus a few in R and I, were obtained during the 1984 eclipse of RZ Ophiuchi. Bolometric corrections and temperature calibration, applied to the magnitudes and colours of the stars, were used to derive the ratio of the stellar radii, and a light curve solution was obtained with this parameter fixed. Neither component fills its Roche lobe, but the system may be at a late stage of case C mass transfer.

The eclipsing binary RZ Ophiuchi consists of a small F type star and a K star that is so much larger and cooler that a) secondary eclipse is undetectable and b) primary eclipse cannot be made to yield all three of r_g, k and i independently (Forbes and Scarfe 1984). In his pioneering study of the system, Baldwin (1978) chose to fix the inclination i at 90°. He concluded that neither star fills its Roche lobe, and thus left unexplained the system's circumstellar matter and evolutionary state. Smak (1981) reinterpreted Baldwin's data on the assumption that the radius of the larger star r_g equals that of its Roche lobe. Forbes and Scarfe showed that either model was consistent with new data from the 1981 eclipse, but suggested that a value of k similar to Baldwin's might be obtained from the stars' bolometric magnitudes and effective temperatures.

However, better photometry was needed to decide the matter finally. To obtain good coverage of the partial phases UBV observations of the 1984 June eclipse were obtained from western North America, Sicily and Australia. In addition a few R and I observations were obtained during totality and outside eclipse. The comparison stars were the same as used by Baldwin, Olson and Hickey (1983) and Forbes and Scarfe and the observations were transformed to the standard system of Landolt (1983).

Colour indices were derived for each star from the eclipse depths, on the assumptions that variations due to the disk eclipse detected by Olson and Hickey are small, and that the disk does not affect the colours significantly. These colours were corrected for reddening using the visual absorption A_V = 0.4 found by Olson and Hickey and were

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then used to estimate effective temperatures and bolometric corrections for the stars. For the hotter star B-V and V-R were matched to Kurucz (1979) model atmospheres, assuming the star to have a supergiant's surface gravity consistent with its F5Ib spectral type and its Stromgren c_1 index. The cooler star's V-R and R-I were converted to the Johnson system and its effective temperature and bolometric correction derived from the tables of Johnson (1966).

The bolometric magnitudes and effective temperatures were used to derive the ratio of the stellar radii, k, and this was imposed on Russell-Merrill solutions of the U, B and V light curves. The results obtained by this procedure were as follows:

Star	Hotter	Cooler
Effective Temperature	6600° ± 250°	3600° ± 200°
Fractional Radius	0.017 ± 0.002	0.13 ± 0.02
Orbit Inclination	90° ± 4°	

Further insight into the physical nature of RZ Oph requires a radial-velocity solution of greater accuracy than the preliminary one of Baldwin. Fortunately M. Mayor has derived a new orbit from CORAVEL observations which he has kindly made available to us. It leads to masses of 5.7 ± 0.2 $M_\odot$ and 0.7 ± 0.1 $M_\odot$ for the hotter and cooler stars respectively. Despite the small size of its Roche lobe, the cool star's radius is only 0.6 that of the lobe.

Thus RZ Oph seems now to be detached, although it has almost certainly undergone considerable mass transfer in the past. It may be that it is an example of Case C mass transfer, for which Lauterborn (1970) predicted a quiescent phase between the major transfer stage and a later lesser one. We believe RZ Ophiuchi may be in this quiescent stage.

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