COMMISSION 27 OF THE I. A. U.
INFORMATION BULLETIN ON VARIABLE STARS
Number 3224

Konkoly Observatory
Budapest
3 August 1988

HU ISSN 0374-0676

A TOTAL ECLIPSE IN RZ CASSIOPEIAE ?

This popular eclipsing binary was observed photoelectrically on seven nights between November 1980 and March 1981 with the 14-inch Schmidt-Cassegrain telescope of the Central Michigan University Observatory. A Pacific Photometrics photometer was used with an unrefrigerated RCA 1P21 photomultiplier and filters to match B and V of the UBV system. Output was recorded on a strip chart recorder.

Differential photometry was obtained using HD 15784 as our comparison star and HD 16769 as a check star. The former was used as the comparison star rather than the latter because (1) it was more nearly the magnitude of RZ Cas and thus changes in amplifier gain could be avoided and (2) HD 16769 is a known short-period spectroscopic binary (Batten, Fletcher, Mann 1978) and might have small light variations due to, for example, the ellipticity effect. Differential photometry between the two showed no evidence of variability, with the rms deviation from the mean being $\pm$ 0^{m}.020 in V and $\pm$ 0^{m}.027 in B.

All of the individual differential magnitudes in V and B, along with the heliocentric Julian dates, have been sent to the I.A.U. Commission 27 Archive for Unpublished Observations of Variable Stars (Breger 1986), where they are available as file no. 156.

Two nights were ideal for determination of times of mid primary eclipse because on both the entire eclipse, from first to fourth contact, was well covered. We applied the method of bisected chords, with points very near the shoulders and the toes ignored. The results were

$$\text{JD(hel.)} = 2{,}444{,}543.7629 \pm 0^{d}.0002$$
$$\text{JD(hel.)} = 2{,}444{,}634.6012 \pm 0^{d}.0003,$$

with no significant difference between V and B, and with no asymmetry significant enough to alter the times by much more than the uncertainties given above. The corresponding O-C residuals, computed with the ephemeris

$$\text{JD(hel.)} = 2{,}429{,}875.6902 + 1^{d}.1952473 \qquad (1)$$

of Herczeg and Frieboes-Conde (1974), were

$$-0^{d}.0022 \pm 0^{d}.0002 \quad \text{(cycle 12272)}$$
$$-0^{d}.0027 \pm 0^{d}.0003 \quad \text{(cycle 12348)}.$$

Although RZ Cas is famous for its small but real period changes (Herczeg and Frieboes-Conde 1974), we will not do a detailed period study here. It is reassuring, however, that O-C residuals of two times of mid primary eclipse obtained by Scarfe et al. (1984) shortly before and after our two times,

$$-0^{d}.0020 \pm 0^{d}.0008 \quad \text{(cycle 12211)}$$
$$-0^{d}.0028 \pm 0^{d}.0001 \quad \text{(cycle 12513)},$$

are consistent.

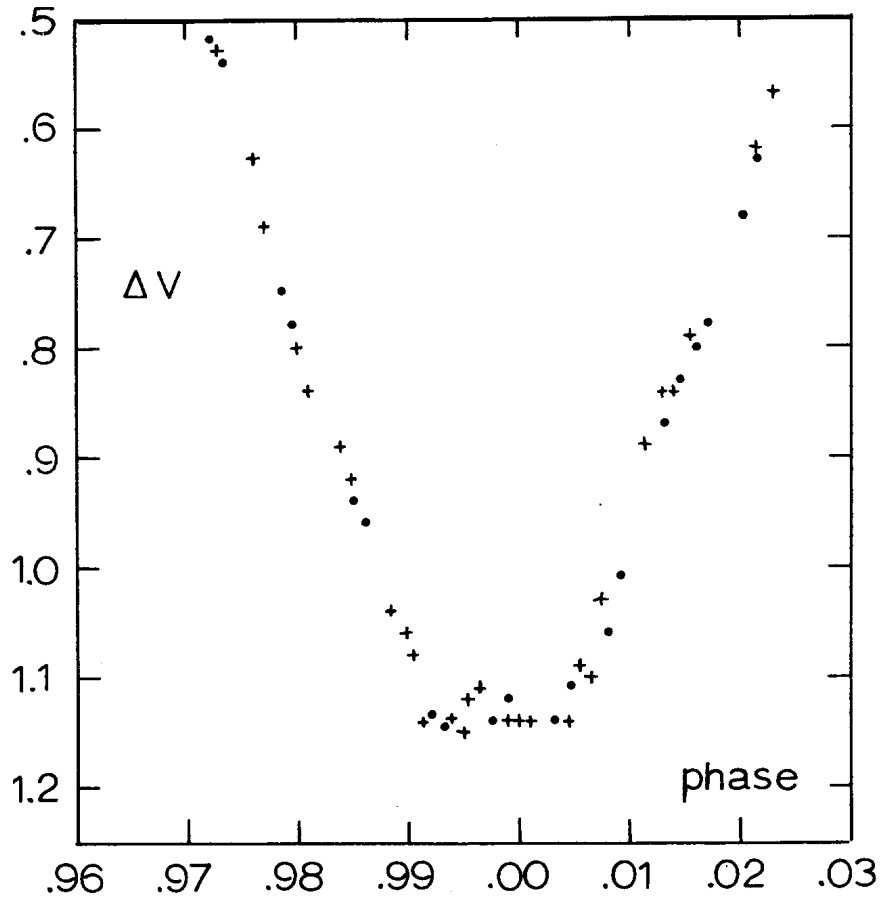

Figure 1. The bottom half of primary eclipse in V. Phase is computed with the ephemeris in equation (1). Notice the 22 minutes of apparently constant light at minimum. Filled circles are from JD 2,444,543 and crosses are from 2,444,634.

The most curious result of our photometry is the clearly apparent total phase, lasting 22 minutes, showing up on both nights and in both bandpasses. This can be seen in Figures 1 and 2. To make the primary eclipse appear partial, one would have to raise 2 or 3 points around second contact **and** 2 or 3 points around third contact, each by about 0^{m}.03 or 0^{m}.04, in both the V **and** the B light curves. Though perhaps possible, this would be an improbable and arbitrary application of Gaussian statistics. The rms deviation of the 15 points within the 22 minutes of apparent totality is only $\pm$ 0^{m}.013 in V and $\pm$ 0^{m}.016 in B.

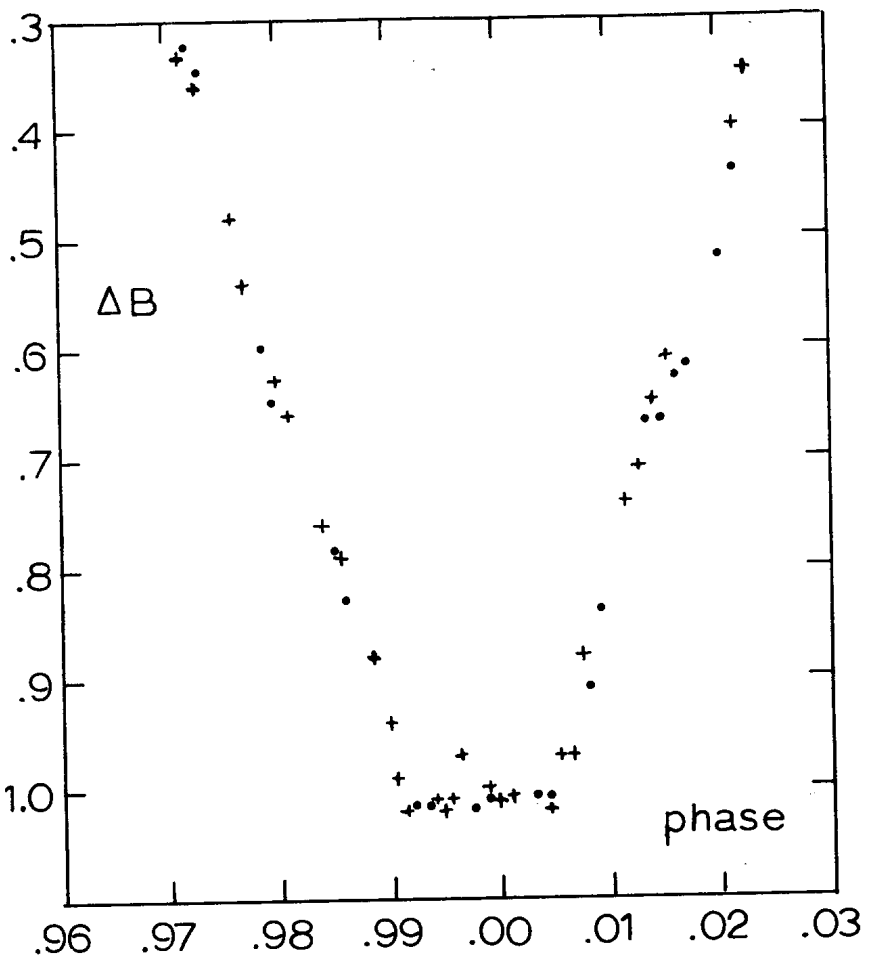

Figure 2. The same as Figure 1, in B.

There are several reasons why we do not believe the primary eclipse actually "became total" on these two nights in 1980 and 1981. According to light curve solutions given by Koch, Plavec, Wood (1970) and by Chambliss (1976), primary eclipse is partial by a wide margin: $\alpha_o = 0.8$. Our primary eclipse depth, in both V and B, is equal to that found by Chambliss, to within a few hundredths of a magnitude; a total eclipse should have been several tenths of a magnitude deeper. The color change in our primary eclipse was less than 0^{m}1, in excellent agreement with that of Chambliss; a total eclipse should have reddened by more than a half magnitude.

Although it is generally thought that primary eclipse in RZ Cas is indeed partial (Nowak and Piotrowski 1982), there have been a few reports in the literature of a constant phase at minimum light: 14 minutes (Szafraniec 1960) and 13 minutes (Burke and Rolland 1966).

We frankly do not know how to interpret our apparent 22-minute constant phase. We make our observations public on the chance that they represent paradoxical behavior which requires explanation. Perhaps there is a relation between RZ Cas and other semi-detached, mass-transfering, Algol-type binaries which have total eclipses that on occassion appear partial: RW Persei (Hall 1969) and U Cephei (Hall and Keel 1977).

DAVID V. ARGANBRIGHT
WAYNE OSBORN
Physics Department
Central Michigan University
Mount Pleasant, Michigan 48859

DOUGLAS S. HALL
Dyer Observatory
Vanderbilt University
Nashville, Tennessee 37235

REFERENCES

Batten, A. H., Fletcher, J. M., Mann, P. J. 1978, P.D.A.O. **15**, No. 5.

Breger, M. 1986, I.B.V.S. No. 2853.

Burke, E. W. and Rolland, W. W. 1966, A.J. **71**, 38.

Chambliss, C. R. 1976, P.A.S.P. **88**, 22.

Hall, D. S. 1969, Astrophy. Space Sci. Library **13**, 171.

Hall, D. S. and Keel, W. C. 1977, Acta Astr. **27**, 167.

Herczeg, T. and Frieboes-Conde, H. 1974, Astron. Astrophys. **30**, 259.

Koch, R. H., Plavec, M., Wood, F. B. 1970, Pub. Univ. Pennsylvania, Astr. Ser., **10**.

Nowak, A. and Piotrowski, S. L. 1982, Acta Astr. **32**, 401.

Scarfe, C. D., Forbes, D. W., Delaney, P. A., Gagne, J. 1984, I.B.V.S. No. 2545.

Szafraniec, R. 1960, Acta Astr. **10**, 99.