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PARTIAL ECLIPSES IN BR CYGNI

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BR Cygni ($\alpha_{2000} = 19^{\rm h}40^{\rm m}54\overset{\rm s}{.}7$, $\delta_{2000} = +46^\circ 47' 05\overset{''}{.}6$, $V = 9.98$) is a classical Algol with a period of about 1.33 days. The SIMBAD database lists its spectral type as A3V and $B - V = 0.05 \pm 0.03$ from Tycho observations, a color consistent with the spectral type. Wehinger (1968) published photometry in yellow and blue filters that showed an odd dependence of the nature of the primary eclipse on wavelength. The yellow light curve showed an apparent totality that lasted approximately 38 minutes while the blue light curve exhibited a partial primary eclipse and Wehringer was unable to explain this unusual behavior. Koch et al. (1979) expressed surprise that no further study of the system had been done.

In order to explore this potentially unusual system, we began observing BR Cyg with BVR_cI_c filters at the Sonoita Research Observatory. We used the 0.35m telescope equipped with a Santa Barbara Instrument Group Research STL-1001XE CCD camera. Calibration (bias, dark, flat) and aperture photometry were done with IRAF.

Observations were made on eight nights in June 2005 with a total of 776 observations with the B filter, 742 in V, 737 in R_c and 738 in I_c. GSC 3556-3216 ($B - V = 0.03 \pm 0.03$ from Tycho) was used as the comparison star. The standard deviation of individual measurements in each filter was about 0.01 magnitudes. The instrumental differential magnitudes for BR Cyg are available from the IBVS web site as 5646-t2.txt (B), 5646-t3.txt (V), 5646-t4.txt (R_c) and 5646-t5.txt (I_c).

Inspection of Figure 1 shows that the primary eclipse is partial in all filters. The light curves show no indications of the odd morphology seen in the Wehinger (1968) data. BR Cyg thus appears to be a normal Algol with the typical small night-to-night variability most likely related to mass transfer from the lobe-filling secondary component. We see no evidence of pulsations (with amplitude greater than the 1% precision of our photometry) as seen in some other Algols (e.g. IU Per observations by Kim, et al., 2005).

We analyzed our observations with the 2003 version of the Wilson-Devinney program (WD; Wilson & Devinney, 1971; Wilson, 1979). The analysis must be viewed as preliminary since the eclipses are partial and we have no radial velocity from which to determine the mass ratio, which is only weakly constrained by the photometry (Terrell & Wilson, 2005). Initial experiments showed that the light curve fits required the secondary to fill its Roche lobe, so we used WD's mode 5 and adjusted the parameters shown in Table 1. We set the mean effective temperature of star 1 (the star eclipsed at primary minimum) equal to 8900 K based on the $B-V$ value and the calibration of Flower (1996). Unadjusted parameters such as the gravity darkening exponents and bolometric albedos were set to their theoretically expected values for radiative and convective envelopes for the primary and secondary respectively. Limb darkening coefficients for the logarithmic limb darkening law were interpolated from the Van Hamme (1993) tables.

Figure 1 shows the fits to the observations. The errors in Table 1 are the formal errors from the differential corrections solution and are probably too optimistic given the actual uncertainty in the mass ratio. The error estimate for T_2 is more correctly interpreted as the error in T_1-T_2 as the assumption of fixing T_1 based on the $B-V$ value involves an uncertainty of the order of 300 K. A spectroscopic study of the system is needed before further progress can be made.

Table 1. Adjusted Parameters for the Light Curve Solution

Parameter	Value	Std. Error†
i	81°.87	0°.04
T_2	5698 K	5 K
q	0.532	0.003
Ω_1	3.872	0.008
HJD_0	2452501.0124	0.0004
P	1d.3327286	0d.0000006
$L_1/(L_1+L_2)_B$	0.905	0.001
$L_1/(L_1+L_2)_V$	0.840	0.001
$L_1/(L_1+L_2)_{R_c}$	0.791	0.001
$L_1/(L_1+L_2)_{I_c}$	0.738	0.001

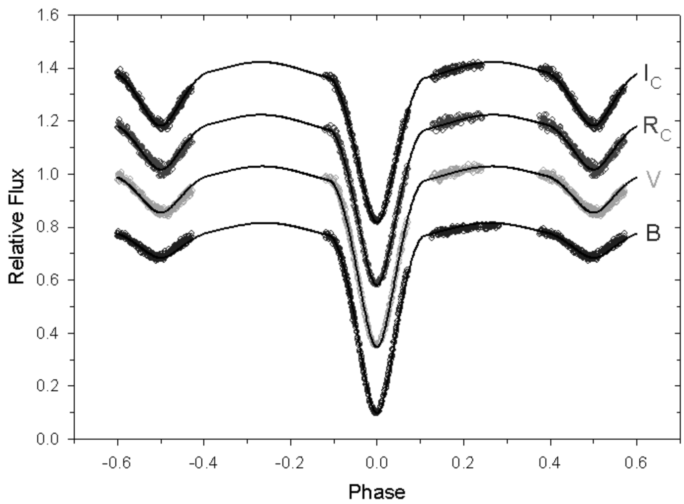

Figure 1. BVR_cI_c light curves of BR Cyg and the fits from the Wilson-Devinney solution.

†Formal errors from the differential corrections solution.

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