COMMISSIONS 27 AND 42 OF THE IAU
INFORMATION BULLETIN ON VARIABLE STARS
Number 5520

Konkoly Observatory
Budapest
5 April 2004
HU ISSN 0374 – 0676

THE SOLAR TYPE NEAR CONTACT BINARY, CR CANIS MAJORIS

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As a part of our search for solar type eclipsing binaries with gas streams we observed the neglected variable, CR Canis Majoris [GSC 5973 1733, $\alpha(2000) = 7^h18^m2^s.14$, $\delta(2000) = -19^\circ40'57''.7$]. Deurinck (1948) gave 16 times of minimum light and a starting ephemeris (recalculated by us),

$$\text{HJD Tmin I} = 2428094.488\ (\pm0.008) + 0.62414\ (\pm.00001)\text{d} \times \text{E}. \tag{1}$$

Standard errors in the last digits are given in parentheses. His photographic light curves suggest that CR CMa is a near contact binary.

The UBVRI light curves of CR CMa were taken at CTIO in Chile with the 0.9-m reflector on 27, 28, 30, 31, December 2002 and 1 January, by RGS. The CFIM 2K×2K T2K CCD camera was used, operating in a 1K×1K quad amplifier mode for fast readouts. Standard UBVR_cI_c Johnson-Cousins filters were used. The stars (GSC 5973 1418, $\alpha(2000) = 07^h18^m15^s.25$, $\delta(2000) = -19^\circ40'27''.7$) and (GSC 5973 2291, $\alpha(2000) = 07^h18^m3^s.86$, $\delta(2000) = -19^\circ40'31''.8$) were the comparison and check stars, respectively. A finding chart of CR CMa (V), the comparison (C) and check star (K) are given in Figure 1. 241 frames in B, 240 V, 238 R and I, and 242 in U were taken. The light curves and color curves of the variable are given in Figure 2 as normalized flux versus phase. Three mean epochs of minimum light were determined from U,B,V,R,I eclipse timings using parabola fits:

$$\begin{aligned} \text{HJD MIN II} &= 2452635.7345 \pm 0.0007 \\ \text{HJD MIN I} &= 2452639.7905 \pm 0.0006 \\ &= 2452641.6634 \pm 0.0008 \end{aligned}$$

We calculated the following linear ephemeris from our observations:

$$\text{HJD Tmin I} = 2452641.6631\ (\pm0.0006) + 00.62408\ (\pm0.00010)\text{d} \times \text{E}. \tag{2}$$

A linear fit to the 19 available timings of minimum light gave:

$$\text{HJD Tmin I} = 2452641.6634\ (\pm0.0052) + 0.624141545\ (\pm0.0000002)\text{d} \times \text{E}. \tag{3}$$

Our light curves were phased with Equation 2. Our $B - V$ color indices indicated a spectral type of F3V for the variable and the comparison stars. The check star was G0V.

We first used Binary Maker 2.0 (Bradstreet, 1992) to pre-model the light curves. Both V1010 Oph and Algol semidetached configurations were tried. Only the second of these gave satisfactory fits to the light curves. This is the configuration where the smaller, cooler star fills its Roche lobe and the hotter primary star is under filling.

Using these starting values we calculated complete simultaneous 5 color synthetic light curve solutions with the Wilson Code (Wilson & Devinney 1971, Wilson 1990, 1994). Our best solution indicates that the primary component is under-filling its critical Roche lobe (fill-out = 89.76±0.07%) while the secondary component has reached its critical surface. Other parameters include temperature, T_1= 7000 K (fixed), T_2 = 4558 K, mass ratio m_2/m_1 = 0.34 and an inclination of 75.4 degrees. No spots were applied in our present solution. Our solution is shown overlaying the data in Figure 1. A geometrical representation of CR CMa is given in Figure 3.

If mass conservative transfer is taking place with the primary component as the gainer, the period would be increasing and the system is separating. However, the spectral type of the system may lead us to believe that magnetic breaking is acting which would lead to a decreasing period. These effects could be off setting. Plate archival searches and future monitoring of this system will be important providing clues to the actual orbital behavior.

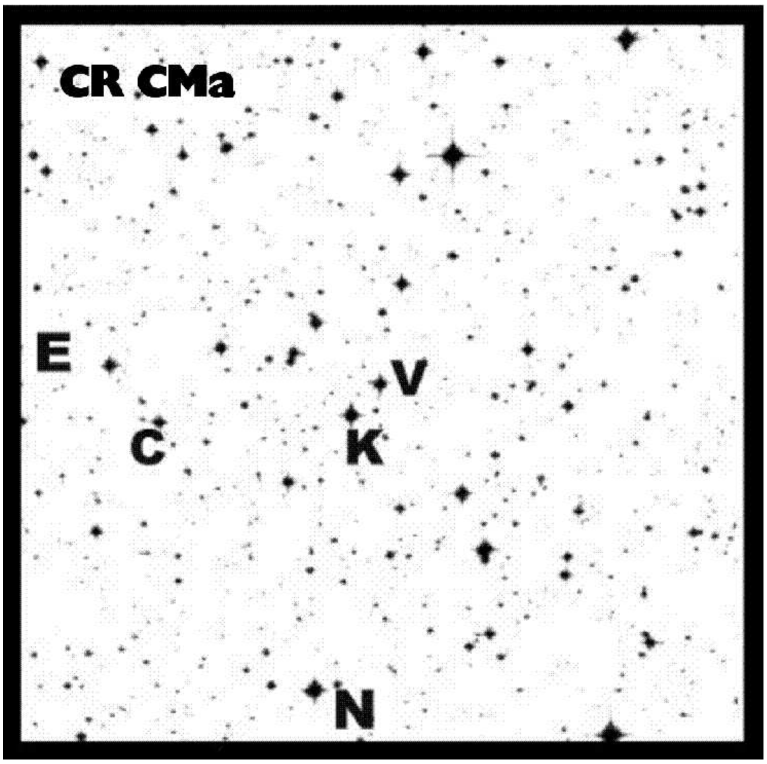

Figure 1.

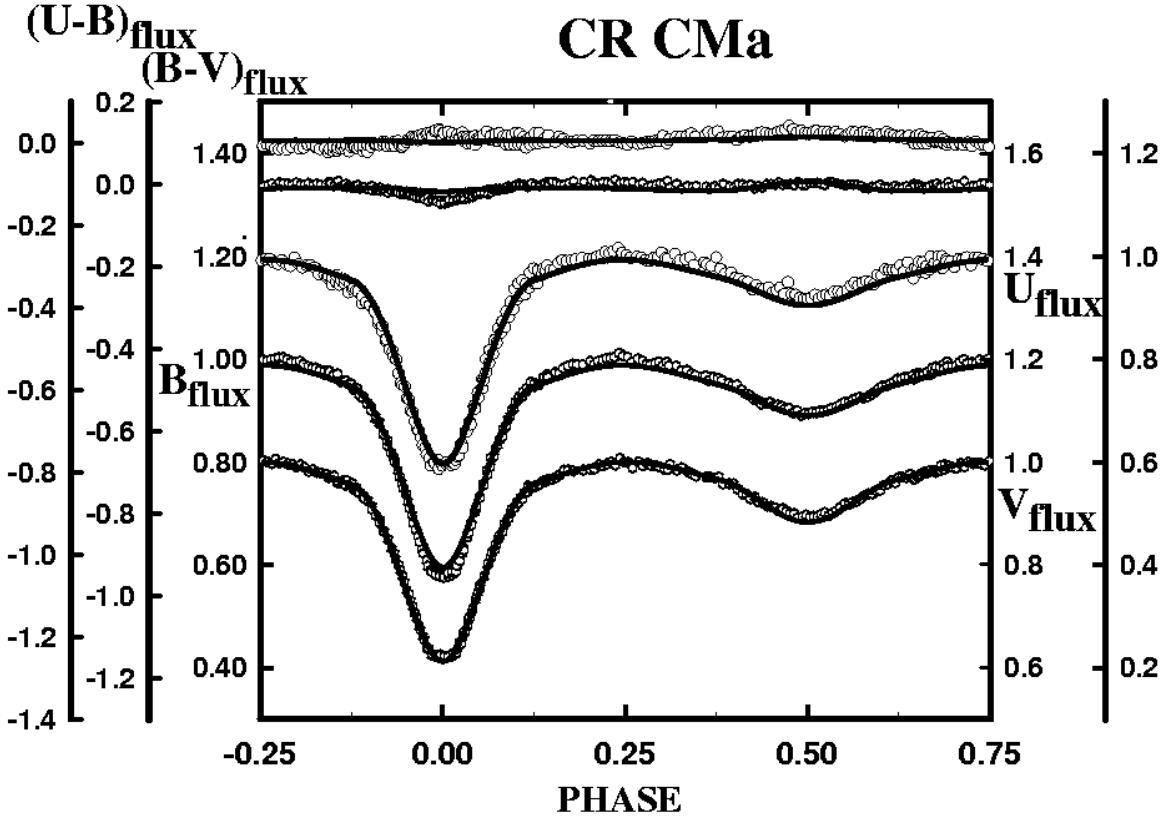

Figure 2.

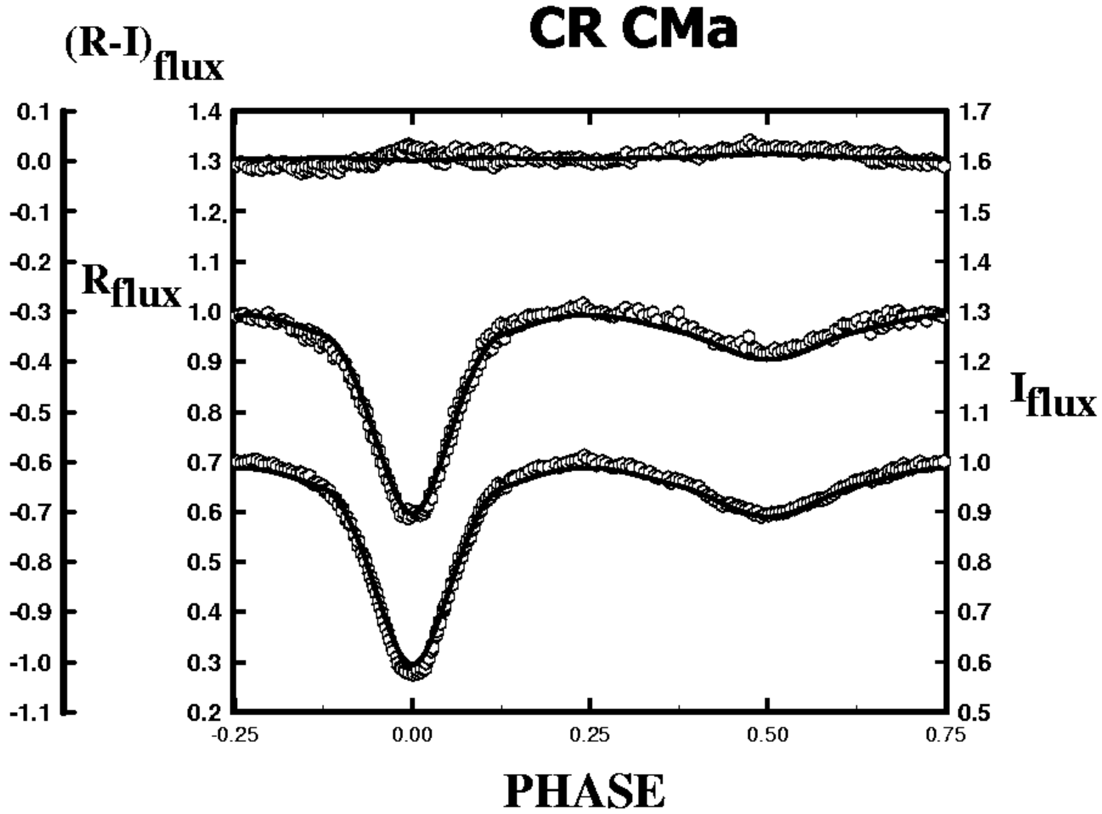

Figure 3.

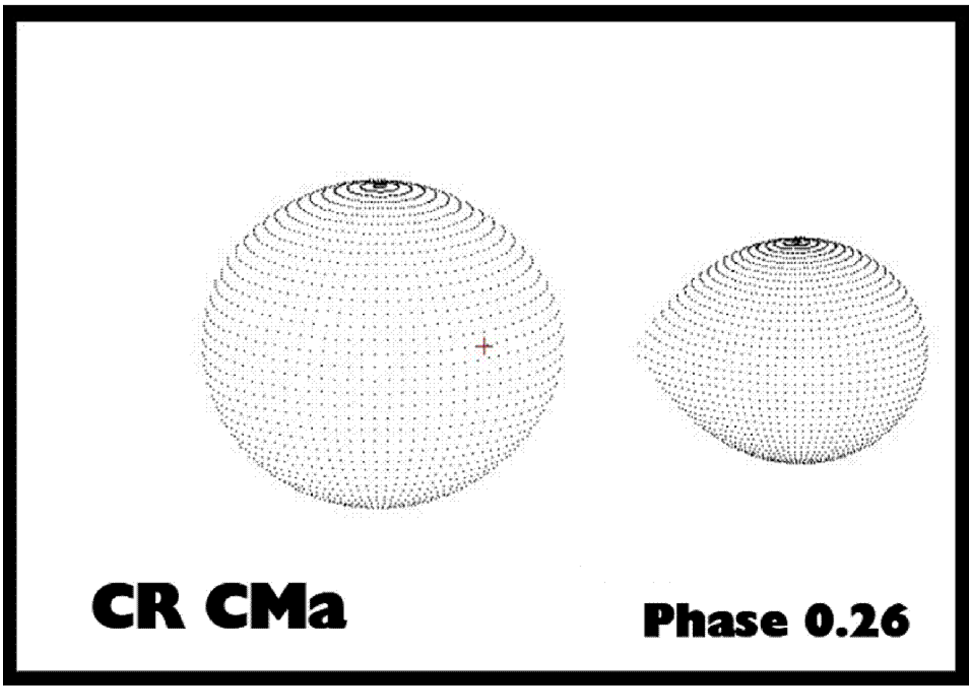

Figure 4.

We wish to thank CTIO for their allocation of observing time, and a small research grant from the American Astronomical Society which supported this run.

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