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UBVRI CCD OBSERVATIONS OF THE G-TYPE CONTACT SYSTEM GSC 2336 0281

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During our recent observations of ST Tri at the SARA telescope, we noticed that our comparison star was variable at a high level. The star was GSC 2336-0281 [$\alpha(2000)=02^{\rm h}41^{\rm m}41\overset{\rm s}{.}0$, $\delta(2000)= +35°42'55''$]. Later, we found that this WUMa binary had been discovered earlier by Zejda (2002). Our observations are reported here.

Light curves were taken at the SARA 0.9-m telescope at Kitt Peak National observatory both on-site on 19, 21-27 December 2003 by RGS, DRF and NCH and in remote mode on 4 and 9 November 2005 by RGS, and NCH. The ST7 CCD camera with standard UBV$R_c I_c$ Johnson-Cousins filters were used. From 127 to 158 observations were taken in the BVRI pass bands and 44 observations were taken in U. CCD advanced calibrations and flux measurements were performed on PC in XP using the APWIN software by NCH and RGS.

The light curves and color curves of the variable are given in Figures 1 and 2 as normalized flux versus phase. The comparison and check stars were the same pair of stars used for ST Tri (Samec 2005).

The finding chart for GSC 2336 0281 has been published (Samec 2005). Our standard magnitudes derived for the system range from F9 to G0 in $B-V$ to G0 to G4 in $V-R$ for this V = 13.48-13.98 magnitude system. We measured an average $U-B$ magnitude of 0.23(1) for the variable at phase 0.25 which is characteristic of a G6 type dwarf single star. This may indicate interstellar reddening and thus magnitude extinction. Four mean epochs of minimum light were determined from B,V,R,I timings of two primary and secondary eclipses: HJD Min II = 2452995.7337(3), 2452999.8481(4) and HJD Min I = 2452996.6688(6), 2452999.6624(8). These were calculated from parabola fits.

We calculated the following ephemeris from all timings:

$$\text{HJD Tmin I} = 2452996.6731(19) + 0.37397969(91)\text{d} \times \text{E}$$

The period appears to have been constant over the 4000 orbits since its discovery. Future precision timings and archival work is needed to reveal the long term period behavior of this system.

We calculated a preliminary but full UBVRI simultaneous synthetic light curve solution to the UBVRI data. Pre-modeling was done with Binary Maker 2.0. This indicated that the system was a W-type, W UMa binary. From the starting parameters, the Wilson code (Wilson & Devinney 1971, Wilson 1990, 1994) was used to do the calculation. Our calculation gave a mass ratio of 0.42, an inclination of 73°.7 and a temperature difference of about 100 K. The Roche-lobe configuration has a 22% fill-out. A full tabled solution is given as Table 1. A cool spot is adjusted on the more massive, cooler component. The solution gave a colatitude of 70° and a longitude of near zero putting it on the "neck" of the Roche Lobe where intercomponent mass flow or streaming is expected. This has also been detected on other contact systems. The solution is shown overlaying the data in Figure 1 and 2. A geometrical representation of GSC 2336-0281 with a spot is given in Figure 3. For systems without total eclipses, radial velocity curves are needed to determine a definitive mass ratio. So our solution is preliminary.

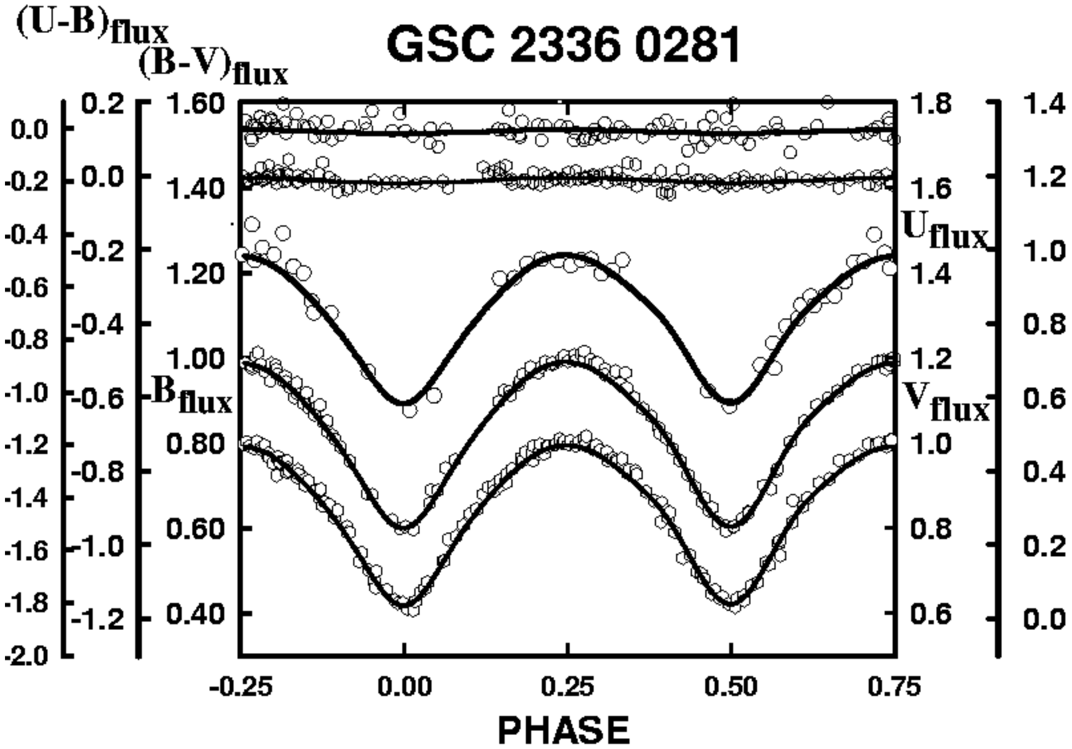

Figure 1.

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

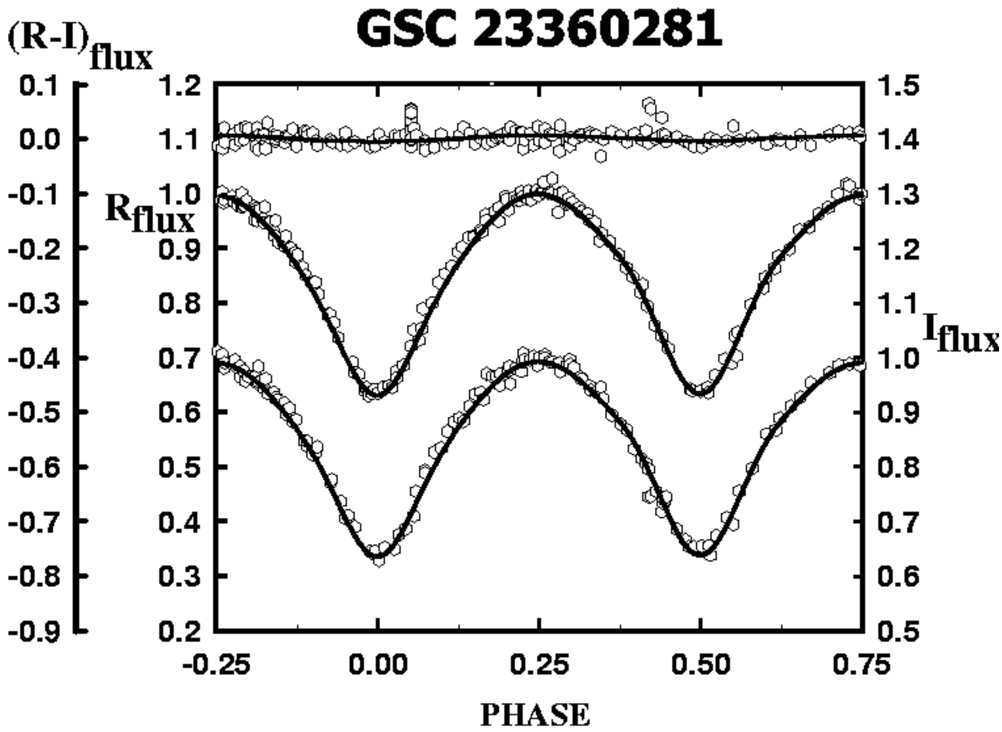

Figure 2.

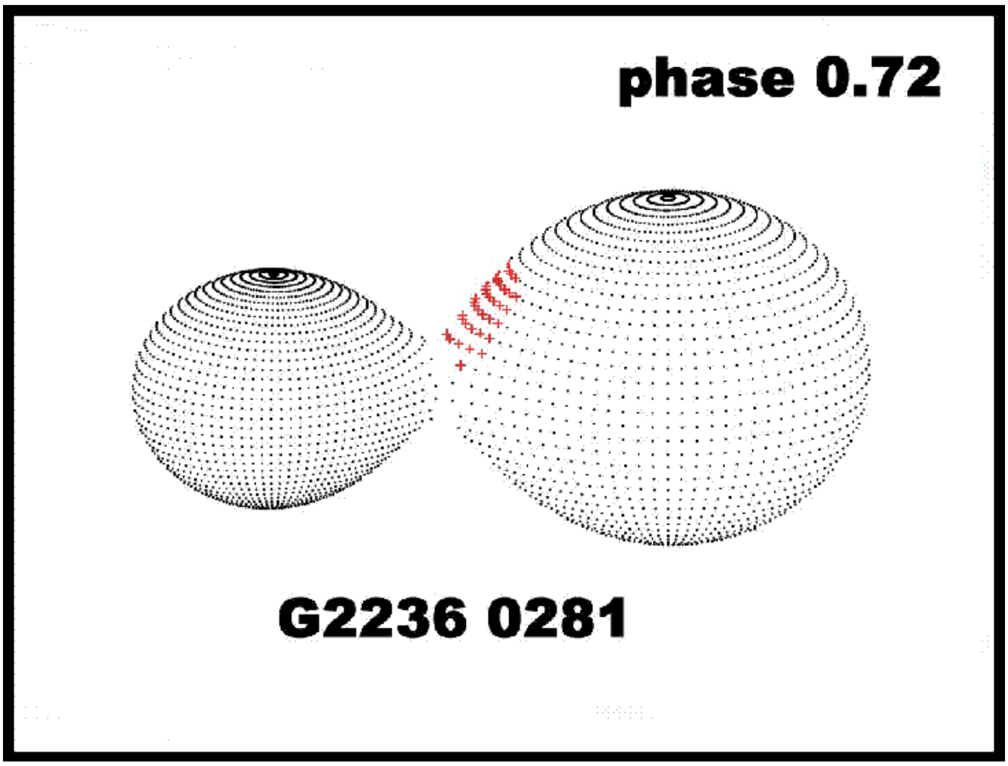

Figure 3.

TABLE I

Synthetic light curve parameters for GSC 2336 0281

λ_B, λ_V, λ_R, λ_I (nm)	440, 550, 640, 790
x_{1B}, x_{2B}, y_{1B}, y_{2B}	0.877, 0.877, −0.024, −0.024
x_{1V}, x_{2V}, y_{1V}, y_{2V}	0.847, 0.847, 0.098, 0.098
x_{1R}, x_{2R}, y_{1R}, y_{2R}	0.778, 0.778, 0.200, 0.200
x_{1I}, x_{2I}, y_{1I}, y_{2I}	0.623, 0.623, 0.230, 0.230
g_1, g_2	0.32, 0.32
A_1, A_2	0.500, 0.500
x_{bol1}, x_{bol2}, y_{bol1}, y_{bol2}	0.649 , 0.649, 0.193 , 0.193
Inclination	$73\overset{\circ}{.}2 \pm 0\overset{\circ}{.}1$
T_1, T_2 (K)	5500 (fixed), 5608 ± 8
$\omega_{1,2}$	2.659 ± 0.002
q (m_2/m_1)	0.418 ± 0.001
pshift	0.9988 ± 0.0002
$L_1/(L_1+L_2)U$	0.653 ± 0.004
$L_1/(L_1+L_2)B$	0.659 ± 0.002
$L_1/(L_1+L_2)V$	0.665 ± 0.002
$L_1/(L_1+L_2)R$	0.667 ± 0.002
$L_1/(L_1+L_2)I$	0.671 ± 0.002
r_1, r_2 (pole)	0.439 ± 0.001, 0.297 ± 0.002
r_1, r_2 (side)	0.471 ± 0.001, 0.311 ± 0.002
r_1, r_2 (back)	0.502 ± 0.001, 0.351 ± 0.004
fill-out	22%
Spot Parameters:	Primary Component
Colatitude	$70\overset{\circ}{.}8 \pm 0\overset{\circ}{.}9$
Longitude	$2\overset{\circ}{.}9 \pm 0\overset{\circ}{.}1$
Spot radius	$15\overset{\circ}{.}7 \pm 0\overset{\circ}{.}2$
Temperature factor	0.865 ± 0.004

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