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GSC 3449-0688 - A NEW SOLAR-TYPE OVERCONTACT BINARY

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GSC 3449-0688 ($10^h45^m15^s+52°16'49''$, 2000.0) was discovered to be variable by RHN on 2004 February 18 during filtered CCD observations of nearby BH UMa. Further CCD observations by RHN and TK over the next few nights and into March quickly established a period. Table 1 contains all the available times of minimum and deviations from the best fit linear relation.

Table 1. Observed minima of GSC 3449-0688

HJD - 2400000	Error	Type	Cycle	$O-C$ (days)	Observer
53053.804	0.01	I	−3	−0.002	Nelson
53053.974	0.01	II	−2.5	−0.004	Nelson
53054.8371	0.0001	I	0	0.0000	Nelson
53055.3529	0.0003	II	1.5	0.0000	Krajci
53055.5253	0.0002	I	2	0.0005	Krajci
53057.7602	0.0002	II	8.5	0.0003	Nelson
53057.9317	0.0002	I	9	−0.0001	Nelson
53058.9635	0.0002	I	12	0.0001	Nelson
53059.6509	0.0010	I	14	−0.0002	Nelson
53066.8716	0.0006	I	35	−0.0006	Nelson
53067.0450	0.0006	II	35.5	0.0009	Nelson
53074.7807	0.0003	I	58	−0.0002	Nelson
53074.9528	0.0003	II	58.5	−0.0001	Nelson
53077.7032	0.0003	II	66.5	−0.0005	Nelson
53077.8758	0.0002	I	67	0.0001	Nelson

The following elements were determined (where the numbers in brackets are the errors in the units of the last digit):

$$\text{JD Hel Min I} = 53054.8371(1) + 0.343854(4)\text{E}$$

A total of 135 and 162 observations in V and Rc respectively was made by RHN at the Sylvester Robotic Observatory (see Nelson 2002b). They were reduced using MIRA by

Table 2. Positions and magnitudes

Star	GSC 3449-	RA HH.MMSSss	Dec DD.MMSSs	V mag	Error mag	$B-V$ mag	Error mag	$V-R$ mag	Error mag
Variable	0688	10.451472	52.16485	13.686	0.242	0.640	0.002	0.400	0.005
Comp	0707	10.453084	52.10144	11.590	0.018	0.681	0.005	0.366	0.008
Check	0726	10.451102	52.12136	13.103	0.006	0.547	0.016	0.319	0.006

Axiom Research (for Windows; this platform was used by Nelson throughout his part of the study), in the usual way (ibid).

Henden (2004) used the USNO Flagstaff Station 1.0-m. telescope equipped with a SITe/Tektronix 1024×1024 CCD to observe the field in the standard Johnson-Cousins BVRcIc passbands on several photometric nights, using Landoldt standards to calibrate the field. Astrometry is based on USNO-A 2.0 and has errors less than 100mas internal error. Comparison and check stars were standardized as follows in Table 2:

Assuming no interstellar reddening (a reasonable assumption at the galactic latitude of 55 degrees) and main sequence stars, a colour index of $B-V=0.64$ implies a spectral type of G3 and a $\log g$ value of 4.444 (cgs units, Allen, 1973), and a primary temperature T1 = 5751 K (Flower, 1996).

The photometric data were analyzed by the Wilson Devinney (WD) light curve analysis program (Wilson and Devinney, 1971, Wilson, 1990) using an interface program, 'WD-Wint' written by the author (see Nelson, et al., 2002b). The general appearance of the curve suggested an overcontact binary; hence mode 3 was chosen. The following settings were selected: convective envelopes (appropriate for solar-type stars), giving albedos of A1 = A2 = 0.5 and gravity exponents of g1 = g2 = 0.32 and the logarithmic (LD=2) limb darkening law, appropriate for cooler stars (Bessell, 1979). Limb darkening values were found from a program by Terrell (1994) that interpolates from van Hamme's tables (van Hamme, 1993). Black body radiation was used initially, but later runs employed the atmosphere option of WD taken from the Carbon and Gingerich atmospheres (Carbon & Gingerich, 1969).

After a best-fit solution was found, third light was tested for and the predicted correction less than the estimated error. Therefore third light may be ruled out. The final values are given in Table 3, the final light curves are plotted in Figure 1, and a 3-D representation at phase 0.25 generated by Binary Maker 3-D (Bradstreet, 1993) is shown in Figure 2.

Acknowledgements:

Thanks are due to Environment Canada for the website satellite images (see 'Satellite images' below) that were essential in predicting clear times for observing runs in this cloudy locale and to Attila Danko for his Clear Sky Clocks, (see below).

Table 3. Solution parameters

Quantity	Value		Error	Quantity	Value	Error
	Star 1	Star 2				
F	1.000	1.000	[fixed]	q = M2/M1	0.331	0.003
g	0.320	0.320	[fixed]	i (deg)	81.2	0.4
A	0.500	0.500	[fixed]	L1/(L1+L2) (V)	0.704	0.003
x (bol)	0.138	0.138	[fixed]	L1/(L1+L2) (Rc)	0.708	0.003
y (bol)	0.636	0.636	[fixed]	φ_0	0.005	0.0003
x (V)	0.550	0.550	[fixed]	e	0	0.002
y (V)	0.254	0.254	[fixed]	r1 (pole)	0.453	0.002
x (Rc)	0.653	0.653	[fixed]	r1 (side)	0.487	0.003
y (Rc)	0.138	0.138	[fixed]	r1 (back)	0.514	0.002
T1 (K)	5751		[fixed]	r2 (pole)	0.273	0.003
T2 (K)		5921	14	r2 (side)	0.285	0.004
Ω	2.510	2.510	0.009	r2 (back)	0.232	0.006
f (fill factor)	0.12	0.12	0.03	$\Sigma\ \omega^2_{\rm res}$	0.0266	na

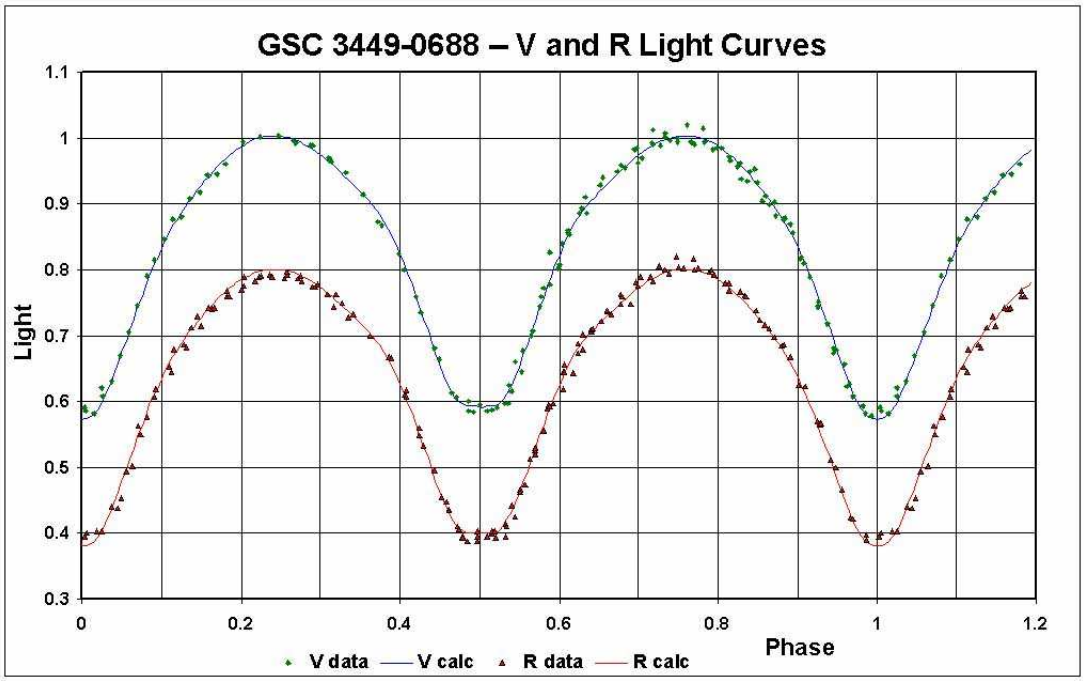

Figure 1.

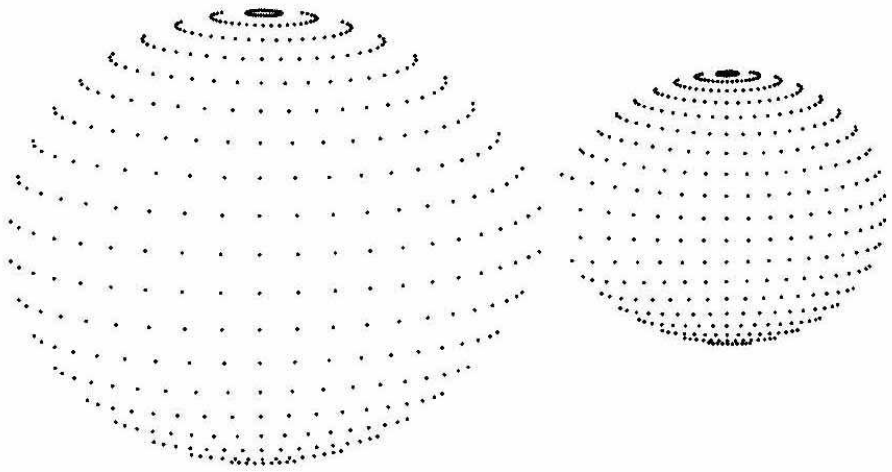

Figure 2.

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