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BVRI CCD OBSERVATIONS OF THE F-TYPE NEAR CONTACT SYSTEM ST TRIANGULI

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As a part of our continuing study of solar type near contact binaries, we observed the rather faint but interesting variable, ST Trianguli [GSC 2336 0305, $\alpha(2000) = 02^h41^m32\overset{s}{.}83$, $\delta(2000) = +35°43'30\overset{''}{.}9$]. The variable was discovered by Hoffmeister (1967) who gave a finding chart, and designated it as an EA system. Kurochkin (1973) and Busch, Haussler, and Splittgerber (1979) gave timings of minimum light, charts and photographic light curves. Busch, Haussler and Splittgerber (1979) and Zejda (2002, 2004) have contributed many additional eclipse timings for this system.

Our present BVRI light curves of ST Tri were taken at the SARA 0.9-m telescope at Kitt Peak National observatory both on-site on 20, 22-27 December 2003 by RGS, DRF and NCH and in remote mode on 4 and 5 November 2005 by RGS, and NCH. The ST7 CCD camera with standard UBVR_cI_c Johnson-Cousins filters were used. From 180 to 200 observations were taken in the BVRI pass bands. CCD advanced calibrations and flux measurements were performed 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 stars (GSC 233 60621 $\alpha(2000) = 02^h41^m29\overset{s}{.}73$, $\delta(2000) = +35°42'36.4''$) and (GSC 2336 0519, $\alpha(2000) = 02^h41^m24\overset{s}{.}20$s $\delta(2000) = +35°44'29\overset{''}{.}2$) were used as comparison and check stars, respectively. Standard star reductions reveal that ST Tri is a 14th magnitude, early F-type system (F2 to F5). The check star is a V = 13.46(2) mag, K5(1)V star, and the comparison is a V= 14.21(2) G0(2) type dwarf.

A finding chart of ST Tri (V), the comparison (C) and check star (K) are given in Figure 3 along with the WU Ma variable GSC 2336 0281. Six mean epochs of minimum light were determined from B,V,R,I timings of two primary and four secondary eclipses: HJD I = 2453000.85415(13), 2453319.9022 (4) and HJD II = 2452995.8239 (8), 2452999.6577(10), 2453313.9182(31) and 2453319.66019(22) using parabola fits. We calculated the following ephemeris from all timings:

$$\text{HJD Tmin I} = 2451550.2872(16) + 0.47905145(19)\text{d} \times \text{E}$$

The period appears to have been constant over the past 30,000 orbital cycles. Future precision timings and archival work is needed to reveal the long term period behavior of this system.

The light curves show an interval of constant light in the secondary eclipse revealing the system to be one of the rare EB binaries with total eclipses. Thus, our solution is unambiguous. Pre-modeling was done with Binary Maker 2.0 (Bradstreet 1992). This indicated that a pre-contact Algol-like model was best. From the starting parameters, a simultaneous BVRI synthetic Wilson code (Wilson & Devinney 1971, Wilson 1990, 1994) solution was calculated. The binary has a secondary, cooler component filling its Roche Lobe and a primary component filling 98% of its associated critical surface. The mass ratio is 0.38 and the temperature difference is about 1900 K. The secondary, less massive component is a K-type dwarf. A hot spot was adjusted on the primary component to a mid-latitude position. Its place precludes it from being a stream impact spot so it would be identified as a facula arising from magnetic activity. An Algol-like configuration usually means that the more massive, now detached star, had once filled its critical Roche surface. Thus, the binary may be approaching its final, W UMa, contact stage. The solution is shown overlaying the data in Figures 1 and 2. A geometrical representation of ST Tri with a spot is given in Figure 4. The complete model is given in Table 1.

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TABLE I

Synthetic light-curve parameters for ST Tri

$\lambda_B, \lambda_V, \lambda_R, \lambda_I$ (nm)	440, 550, 640, 790
x_{1B}, x_{2B}, y_{1B}, y_{2B}	0.794, 0.852, 0.263, −0.018
x_{1V}, x_{2V}, y_{1V}, y_{2V}	0.698, 0.798, 0.256, 0.006
x_{1R}, x_{2R}, y_{1R}, y_{2R}	0.604, 0.797, 0.284, 0.108
x_{1I}, x_{2I}, y_{1I}, y_{2I}	0.514, 0.616, 0.246, 0.16
g_1 , g_2	0.32, 0.32
A_1 , A_2	0.500, 0.500
x_{bol1},x_{bol2},y_{bol1},y_{bol2}	0.641 , 0.643, 0.246 , 0.16
Inclination	$87.^\circ2 \pm 0.^\circ5$
T_1, T_2 (K)	6750, 4890 ± 0.0004
Ω_1, Ω_2	2.670 ± 0.002, 2.6197
q (m_2/m_1)	0.381 ± 0.001
pshift	0.0001 ± 0.0004
$L_1/(L_1+L_2)_B$	0.937 ± 0.001
$L_1/(L_1+L_2)_V$	0.912 ± 0.001
$L_1/(L_1+L_2)_R$	0.895 ± 0.001
$L_1/(L_1+L_2)_I$	0.873 ± 0.001
r_1, r_2 (pole)	0.431 ± 0.001, 0.279 ± 0.001
r_1, r_2 (point)	0.543 ± 0.001, 0.402 ± 0.004
r_1, r_2 (side)	0.459 ± 0.001, 0.290 ± 0.001
r_1, r_2 (back)	0.483 ± 0.001, 0.323 ± 0.009
fill-out$_1$, fill-out$_2$	98.11 ± 0.06%, 100%
Spot Parameters:	Primary Component
Colatitude	121°± 1°
Longitude	$157.^\circ8 \pm 0.^\circ3$
Spot radius	$10.^\circ6 \pm 0.^\circ3$
Temperature factor	1.116 ± 0.005

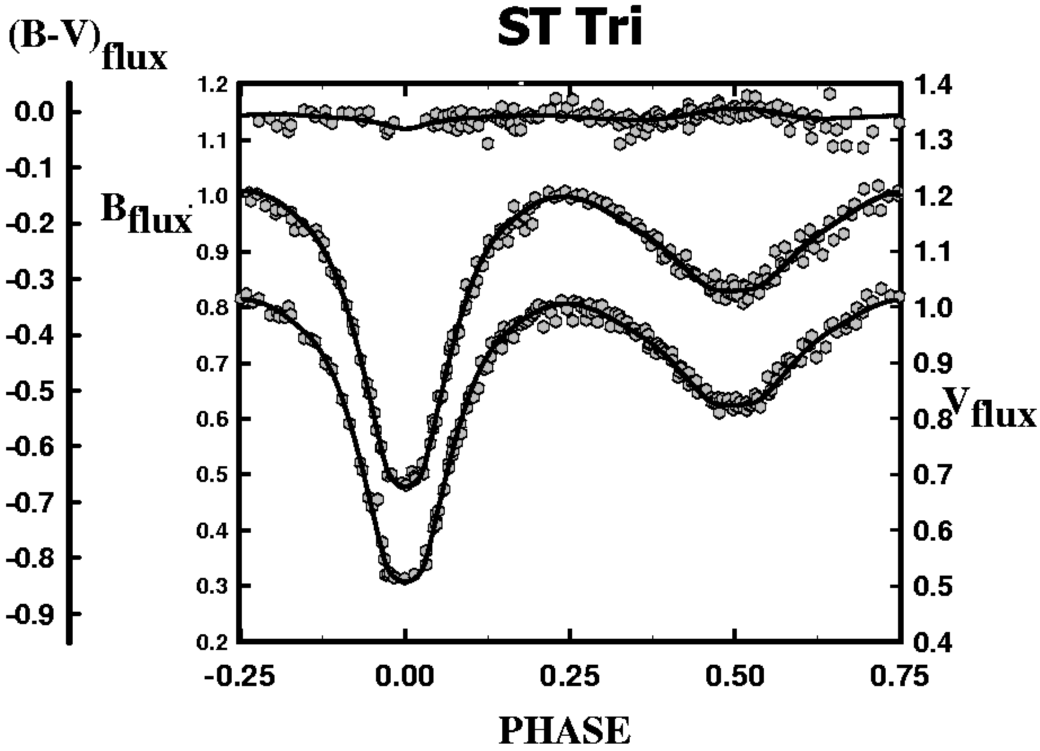

Figure 1.

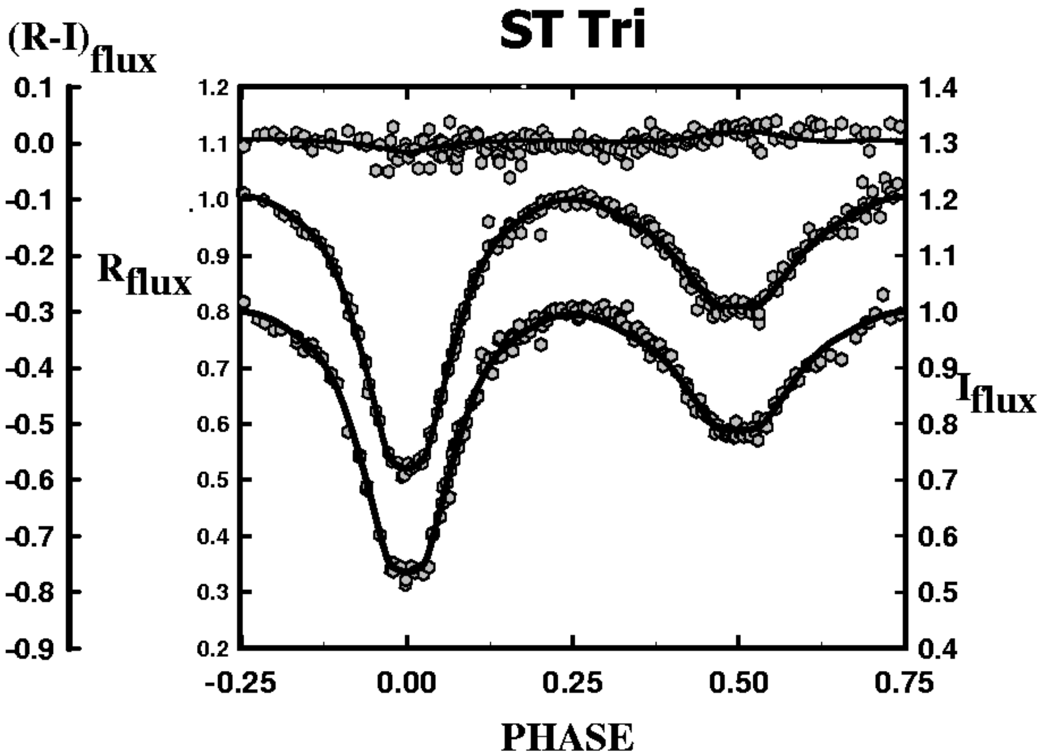

Figure 2.

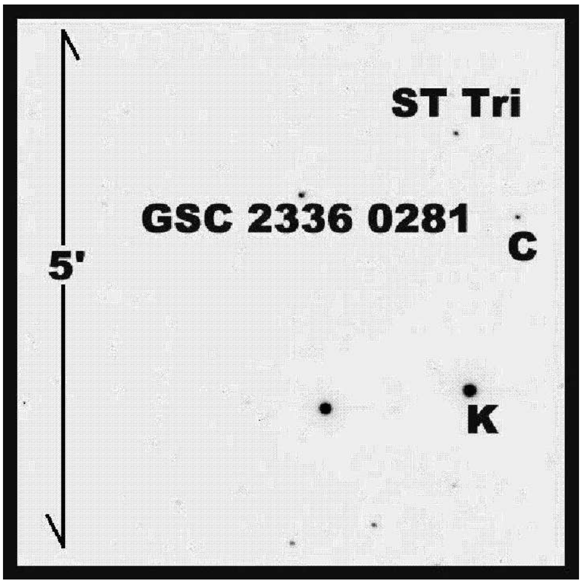

Figure 3.

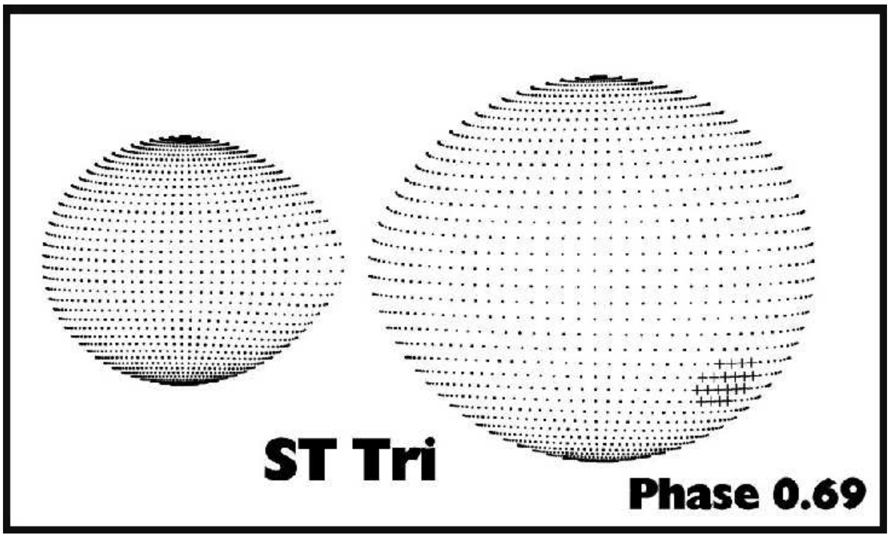

Figure 4.

References:

Bradstreet, D. H., 1992, *BAAS*, **24**, 112 5
Busch, H., Haussler, K., Splittgerber, E., 1979, *VSS*, **9**, H. 2, 125
Hoffmeister, C., 1967, *AN*, **289**, 205
Kurochkin, N.E., 1973, *Variable Stars Suppl.*, **1**, No. 6, 439
Wilson, R. E. & Devinney, E. J. 1971, *ApJ*, **166**, 605
Wilson, R. E. 1990, *ApJ*, **356**, 613
Wilson, R. E. 1994, *PASP*, **106**, 921
Zejda, M., 2002, *IBVS*, 5287
Zejda, M., 2004, *IBVS*, 5583