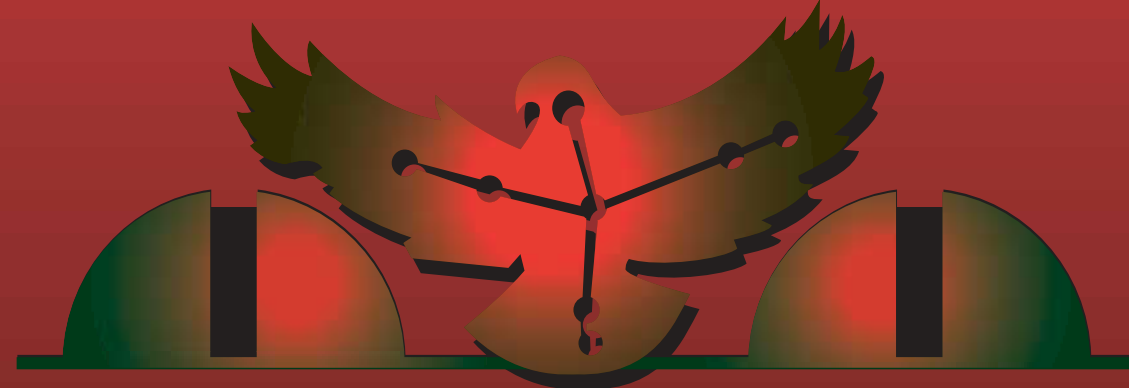


Light Curves and Analyses of the Overcontact Binaries GN Boo, V608 Cas and V789 Cyg

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The Bradstreet Observatory
at Eastern University

New precision V & R_c light curves of the eclipsing overcontact binaries GN Boo, V608 Cas and V789 Cyg have been obtained using the 41-cm telescopes at the Eastern University Observatory equipped with SBIG ST-10XME CCD's.

GN Boo (P = 0.3016 days, m = 10.8) had only one published light curve (Blattler & Diethelm 2001a) which is noisy and had no subsequent analysis. We observed the binary on 5 nights from 3 - 14 Mar 2005, accumulating approximately 680 observations in both V and R_c (shown below). Because the previously published light curve had rather large excursions in light (~0.4 mag in both bandpasses), GN Boo was selected for study with the hope that it would display total eclipses, which it in fact does. Nine timings of minimum light were obtained and combined with all published timings to construct an O-C diagram (see below) to study the period of the system. Although the data perhaps suggest an inverted parabola (thereby demonstrating that the period is decreasing), the number of timings does not cover enough epochs to definitely show this. A linear fit was calculated and the new linear ephemeris is 245344.70949 + 0.3016027E.

The data of both filters were binned into 200 normal points and converted to flux units and then analyzed using the *Binary Maker 3* (Bradstreet & Steelman 2002) and Wilson-Devinney (1971, 1979, 1992) light curve analysis codes. The mass ratio is well constrained by the total primary eclipse and excellent fits were achieved with the introduction of a small, cool starspot on the larger component of the binary. The starspot was necessary in order to effectively model the asymmetric maxima (O'Connell effect). The system is a typical W-type overcontact binary (the smaller star is the hotter component) with a mass ratio of 3.050 and a fillout of 0.2760. The complete results of the analysis are given below.

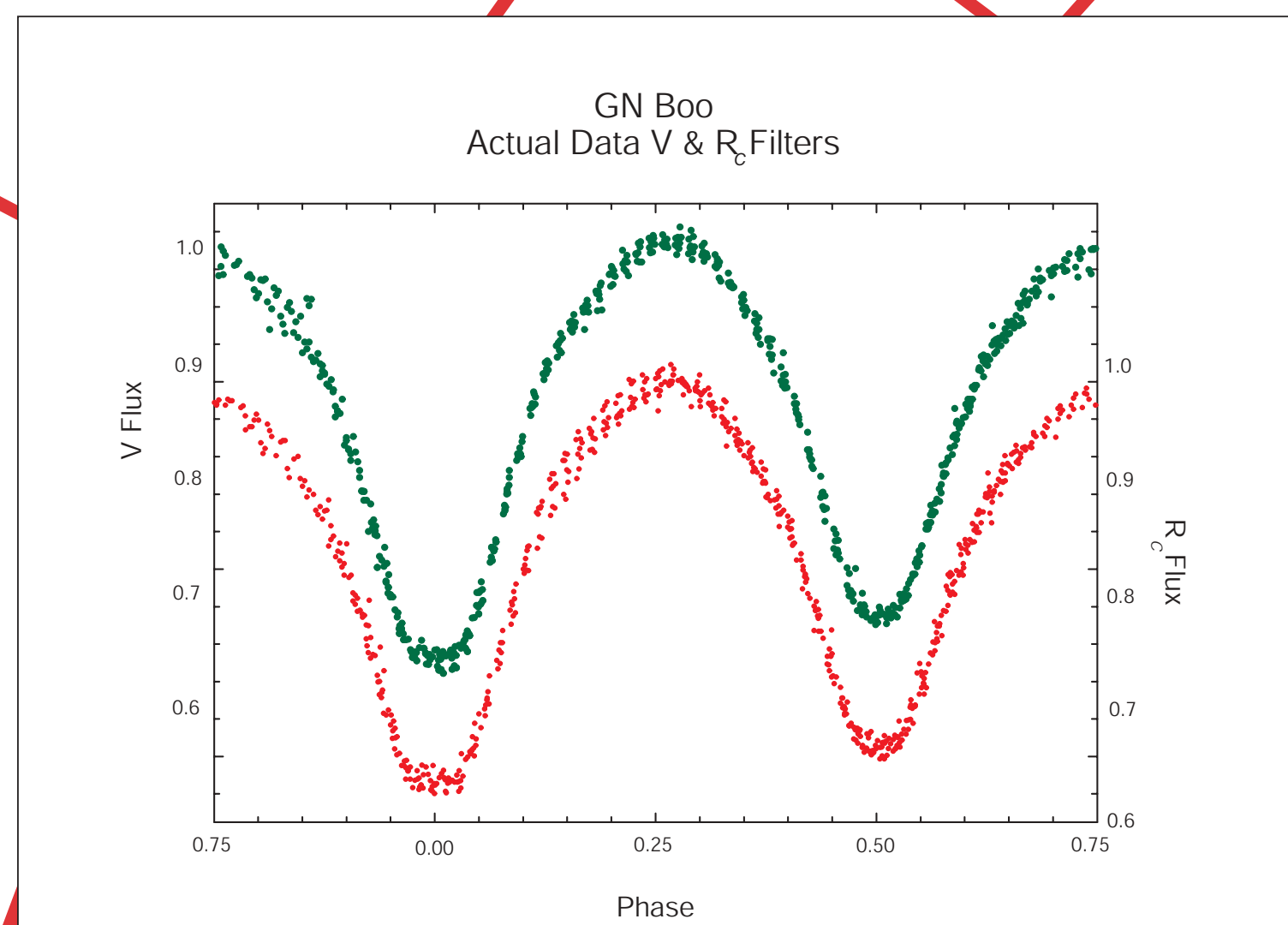
V608 Cas (P = 0.3804 days, m = 12.0) was observed by Blattler & Diethelm (2001b) who published a complete but noisy light curve. V608 Cas was chosen for study because its published light curve suggested possible totality in the eclipses, which (as with GN Boo) turned out to be the case. V608 Cas was observed on 5 nights from 18 Oct - 7 Nov 2004, accumulating approximately 800 observations in both V and R_c. Seven times of minimum light were measured and combined with all published timings for an O-C analysis (see figure below). The ephemeris of Blattler & Diethelm (2001b) was found to be in error in that the eclipses were reversed, i.e., their primary eclipses were actually secondary eclipses and vice versa. In addition, it appears that the period of V608 Cas is decreasing at a rate typical for overcontact systems of dP/dt = -2.37 x 10⁻² sec/yr. The new ephemeris determined for the binary is 2453315.66094 + 0.3803996E.

Light curve analysis was carried out similarly to GN Boo (see above) with excellent results which are shown below. Slightly unequal maxima again required the inclusion of a small, cool starspot on the cooler, more massive component of the binary. V608 Cas is a typical W-type overcontact system (very similar to GN Boo) with a mass ratio of 3.332 and a fillout of 0.2631.

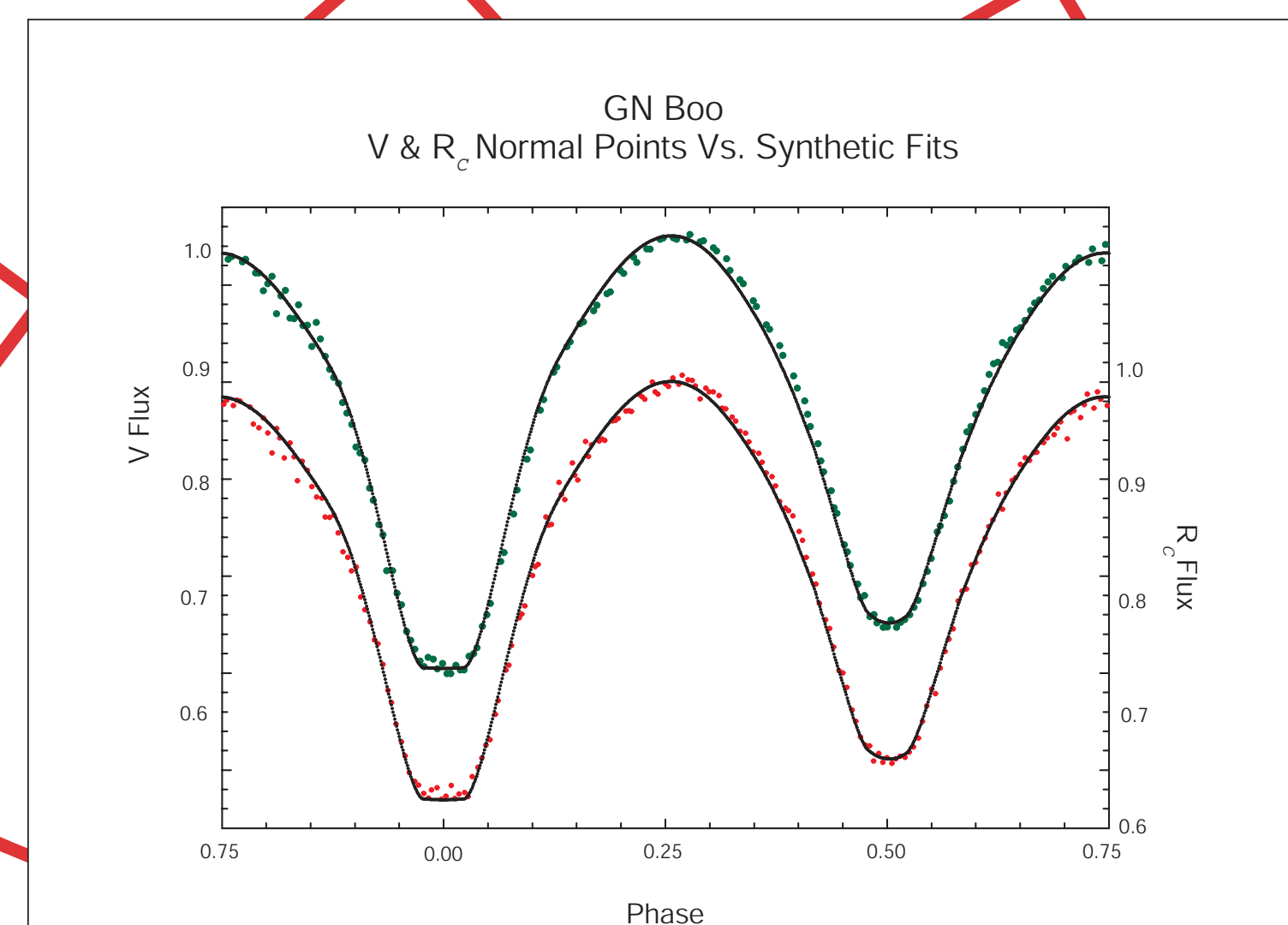
V789 Cyg (P = 0.4478, m = 13.3) is classified in the GCVS as an RR Lyrae variable, and the system was presented as such by Ponce & Sharp (2000). However their light curve looked to us very much like a W UMA light curve folded upon itself with half the true period, and so this system was observed in V and R_c on 8 nights from 27 Jun - 21 Jul 2004 yielding approximately 850 readings in each filter. Five timings of minimum light were obtained and combined with the only existing published timing resulting in the new linear ephemeris of 2453186.66310 + 0.4478446E.

The resulting V & R_c light curves confirmed the overcontact nature of the system, and the light curve solution presented below indicates a W-type overcontact binary with a mass ratio of 1.164 and a fillout of 0.1464. These results must be seen as preliminary since the system exhibits partial eclipses and therefore the mass ratio is not easily determined.

We wish to thank Dr. Jerzy Kreiner for very kindly providing us with all the previously published timings of minimum light for these binaries.



Individual V (green dots) and R_c (red dots) observations of GN Boo



V & R_c synthetic Wilson-Devinney fits (solid curves) to normal points of GN Boo

Light Curve Parameters for GN Boo

(Probable errors given in parentheses)

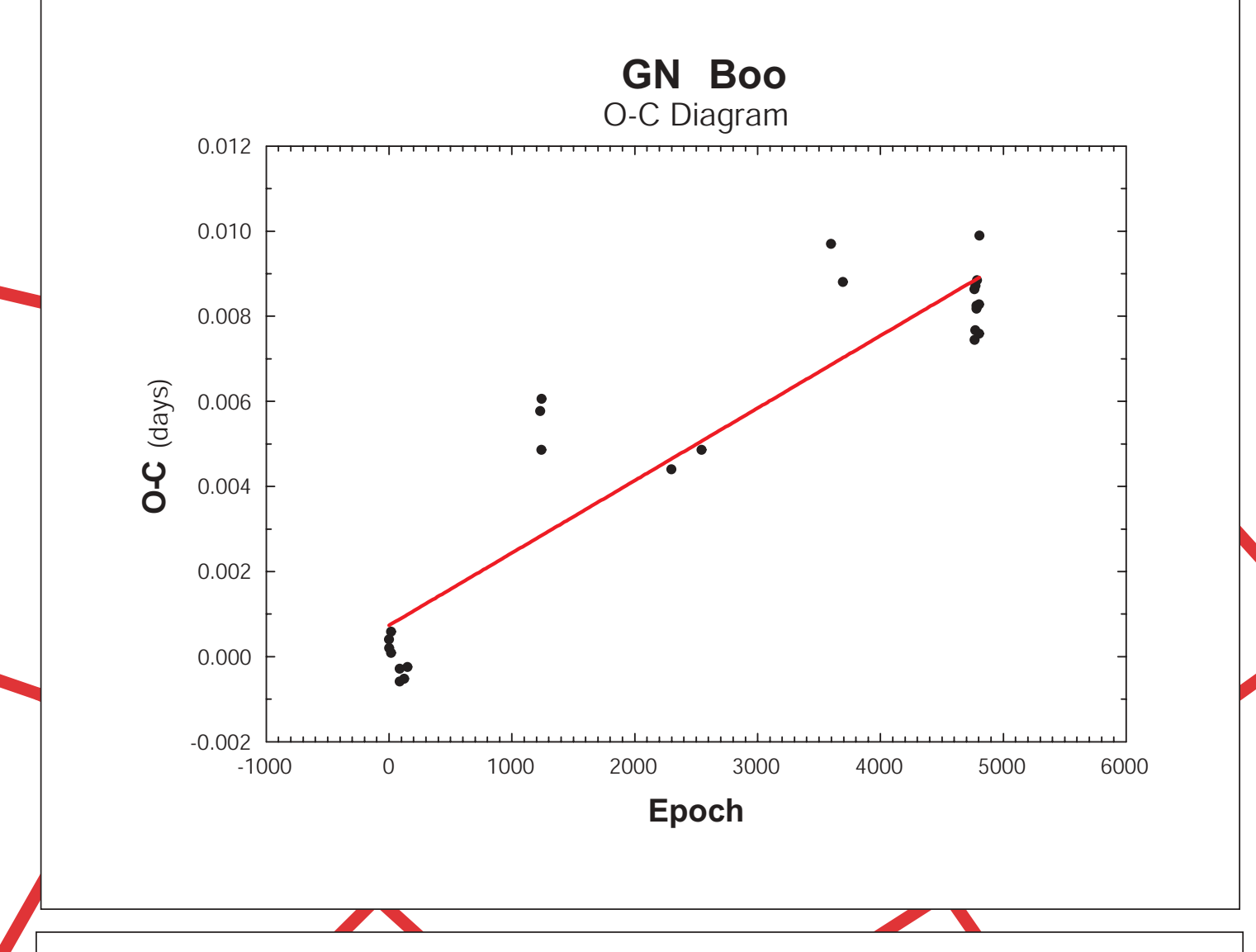
mass ratio	= 3.050 (11)
$\Omega_1 = \Omega_2$	= 6.5114 (120)
fillout	= 0.2760
inclination	= 83°19' (20)
mean density ₁	= 1.310 g/cm ³
mean density ₂	= 1.898 g/cm ³
T ₁	= 5750° K (assumed)
T ₂	= 5374° K (8)
albedo ₁ = albedo ₂	= 0.5 (assumed)
luminosity ₁ = L ₁ (5500 Å)	= 0.3212 (87)
luminosity ₂ = L ₂ (5500 Å)	= 0.6788
limb darkening x ₁ = x ₂ (5500 Å)	= 0.604 (assumed)
luminosity ₁ = L ₁ (6400 Å)	= 0.3130 (76)
luminosity ₂ = L ₂ (6400 Å)	= 0.6870
limb darkening x ₁ = x ₂ (6400 Å)	= 0.520 (assumed)
gravity brightening g ₁ = g ₂	= 0.32 (assumed)

Stellar Radii

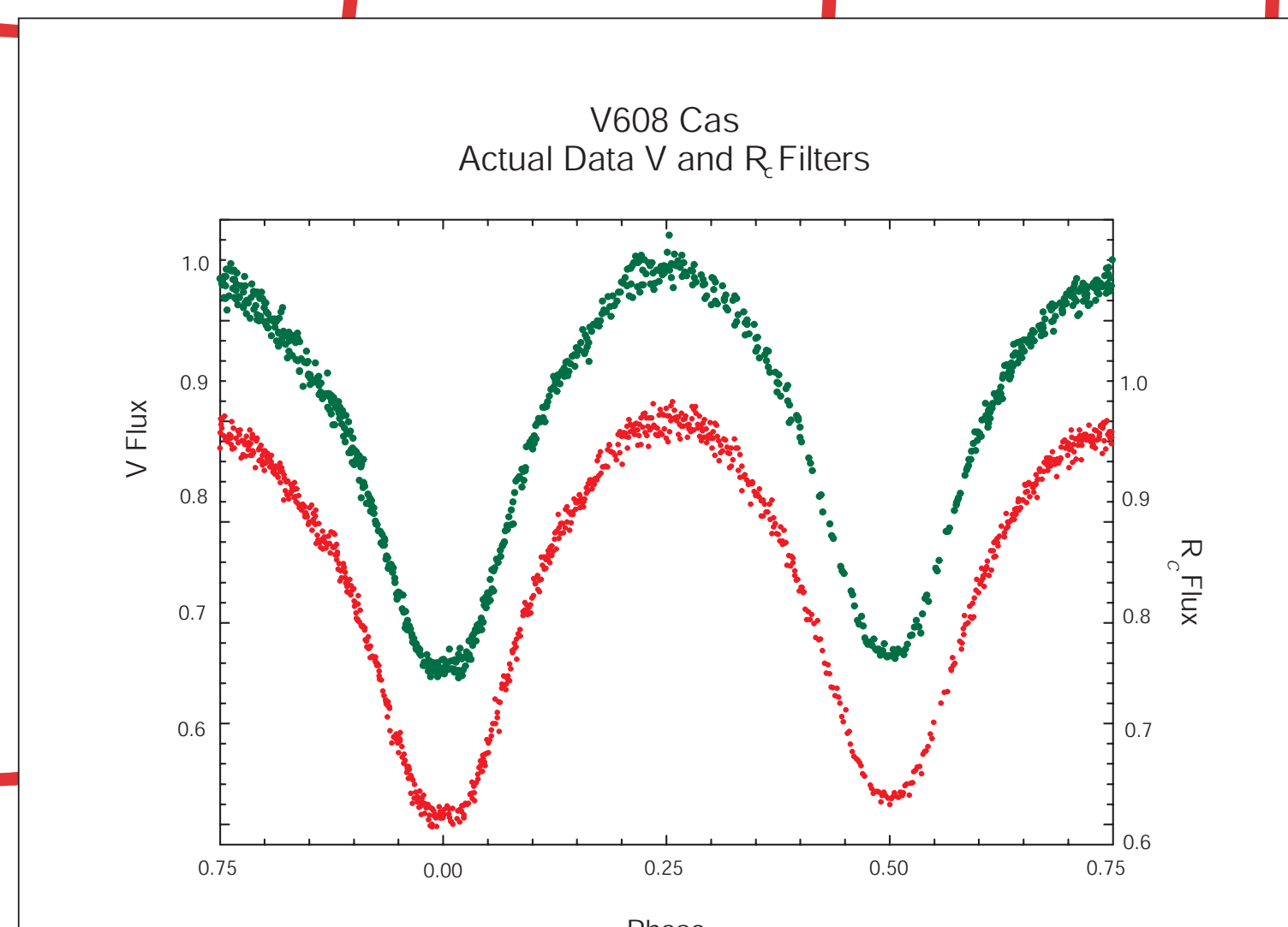
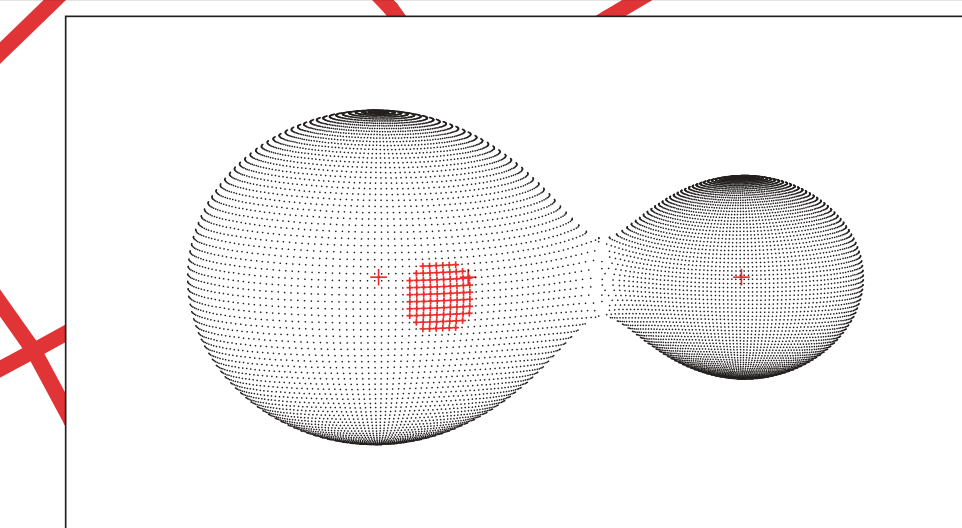
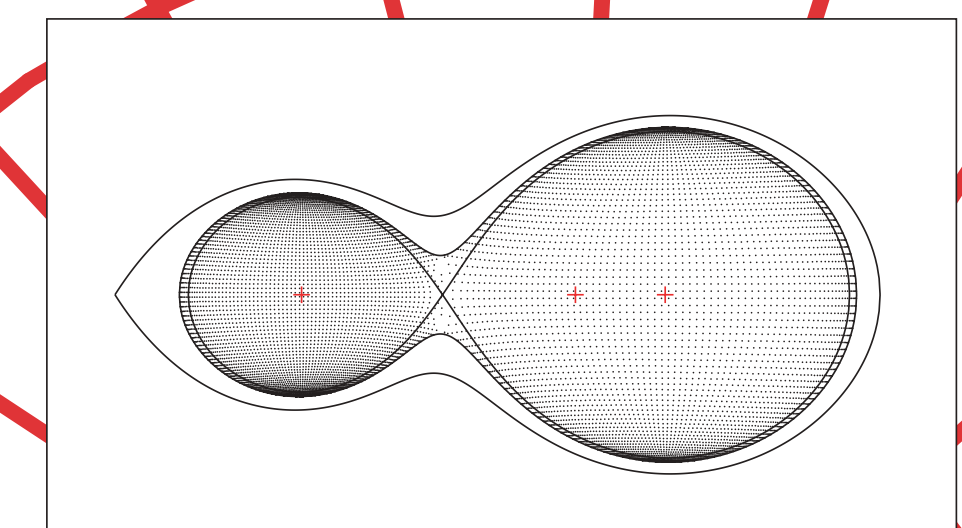
r _{1, back}	= 0.33619 (133)	r _{2, back}	= 0.52644 (35)
r _{1, side}	= 0.29321 (162)	r _{2, side}	= 0.49664 (21)
r _{1, pole}	= 0.27978 (133)	r _{2, pole}	= 0.46017 (14)

Spot Parameters on Star 1

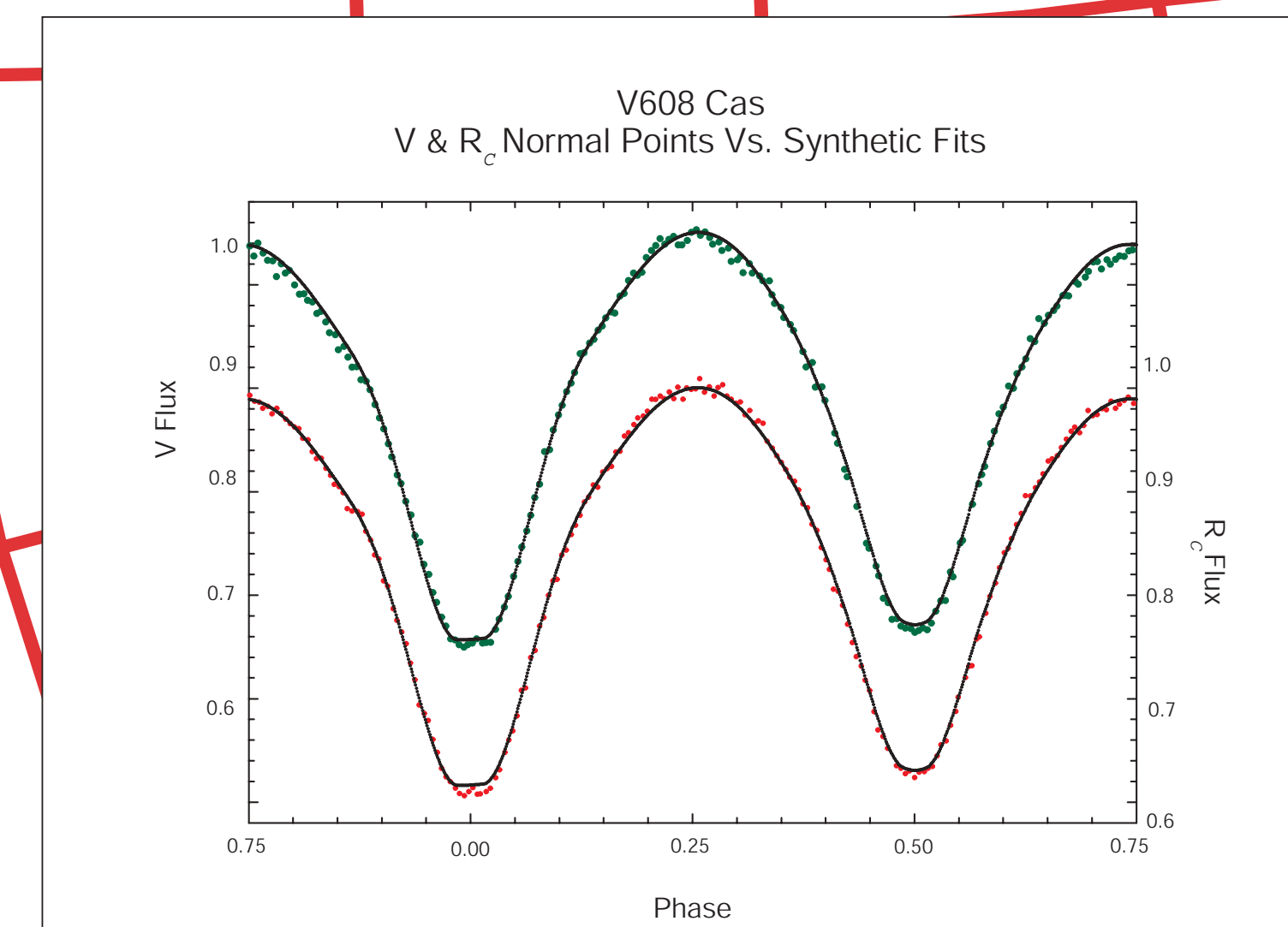
Latitude	Longitude	Radius	Temperature Factor
90°0'	290°0'	12°0'	0.85



Linear fit to the O-C residuals of GN Boo; the solid circles represent CCD timings.



Individual V (green dots) and R_c (red dots) observations of V608 Cas



V & R_c synthetic Wilson-Devinney fits (solid curves) to normal points of V608 Cas

Light Curve Parameters for V608 Cas

(Probable errors given in parentheses)

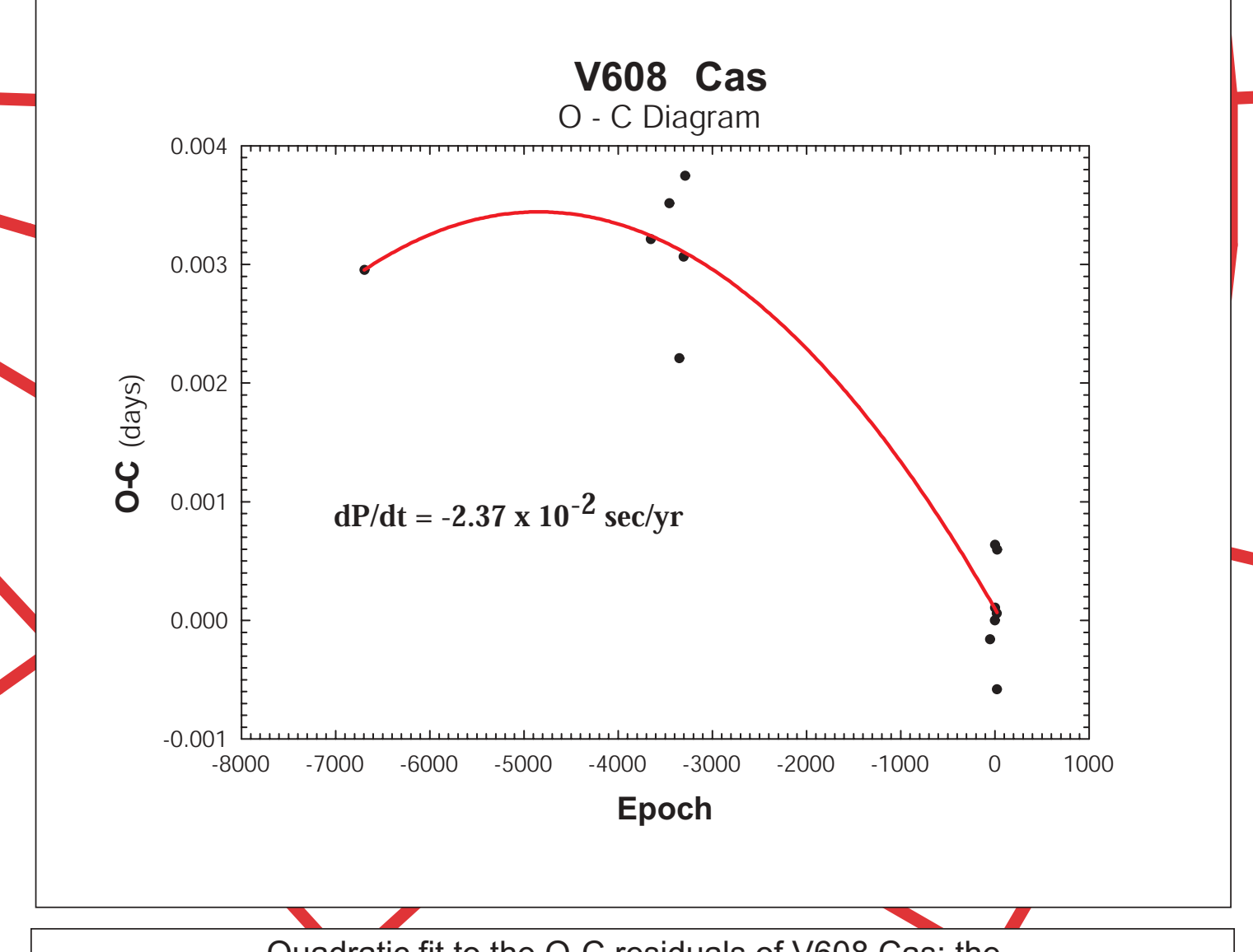
mass ratio	= 3.332 (9)
$\Omega_1 = \Omega_2$	= 6.8883 (125)
fillout	= 0.2631
inclination	= 80°19' (10)
mean density ₁	= 0.808 g/cm ³
mean density ₂	= 1.210 g/cm ³
T ₁	= 6000° K (assumed)
T ₂	= 5808° K (3)
albedo ₁ = albedo ₂	= 0.5 (assumed)
luminosity ₁ = L ₁ (5500 Å)	= 0.2695 (104)
luminosity ₂ = L ₂ (5500 Å)	= 0.7305
limb darkening x ₁ = x ₂ (5500 Å)	= 0.573 (assumed)
luminosity ₁ = L ₁ (6400 Å)	= 0.2670 (103)
luminosity ₂ = L ₂ (6400 Å)	= 0.7330
limb darkening x ₁ = x ₂ (6400 Å)	= 0.491 (assumed)
gravity brightening g ₁ = g ₂	= 0.32 (assumed)

Stellar Radii

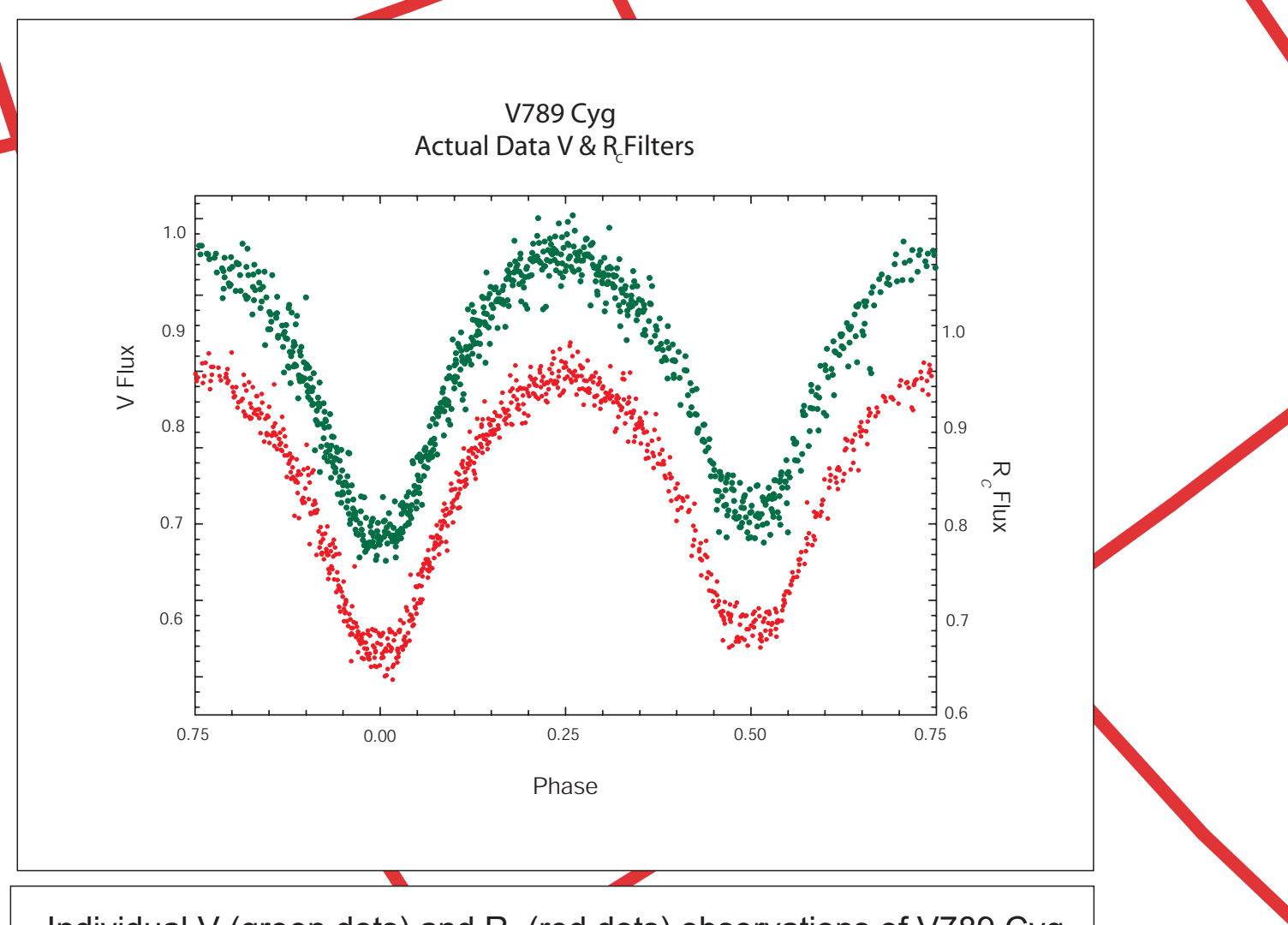
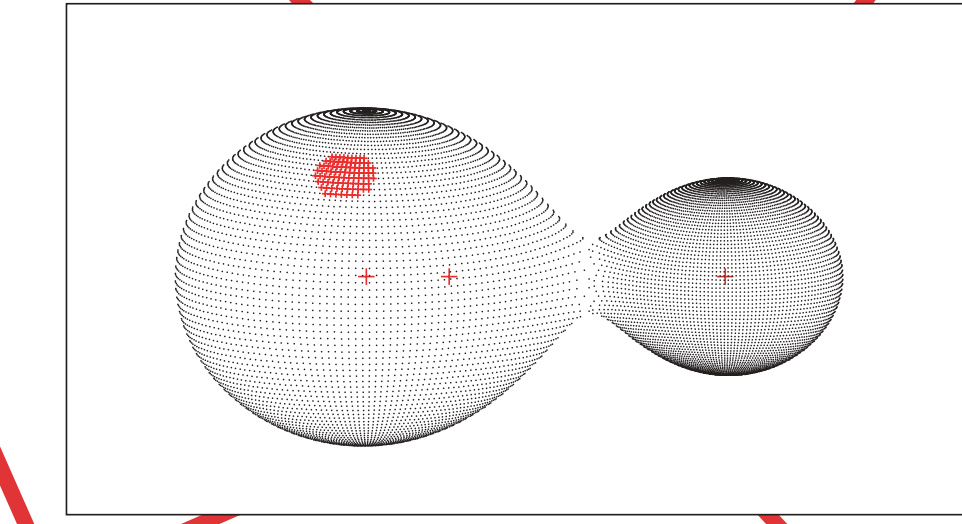
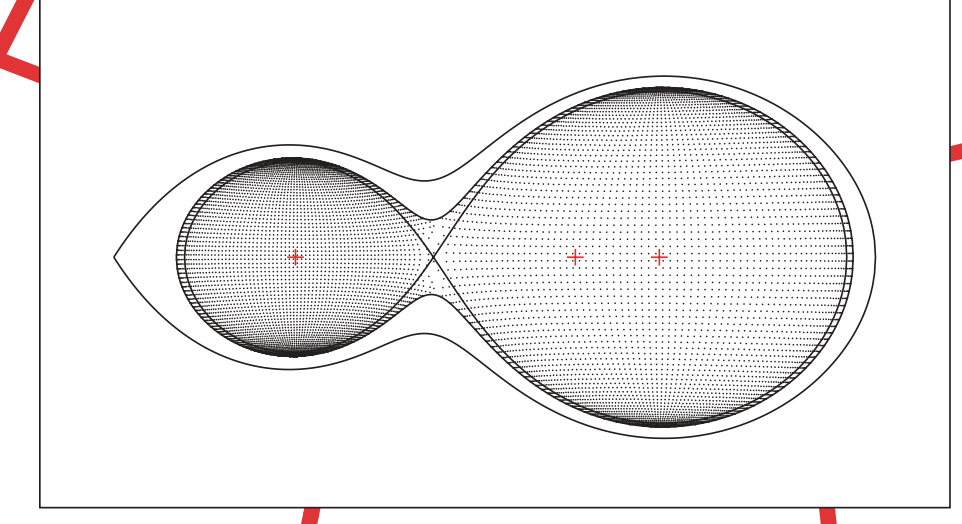
r _{1, back}	= 0.32729 (54)	r _{2, back}	= 0.53275 (10)
r _{1, side}	= 0.28507 (66)	r _{2, side}	= 0.50400 (16)
r _{1, pole}	= 0.27223 (154)	r _{2, pole}	= 0.46615 (10)

Spot Parameters on Star 1

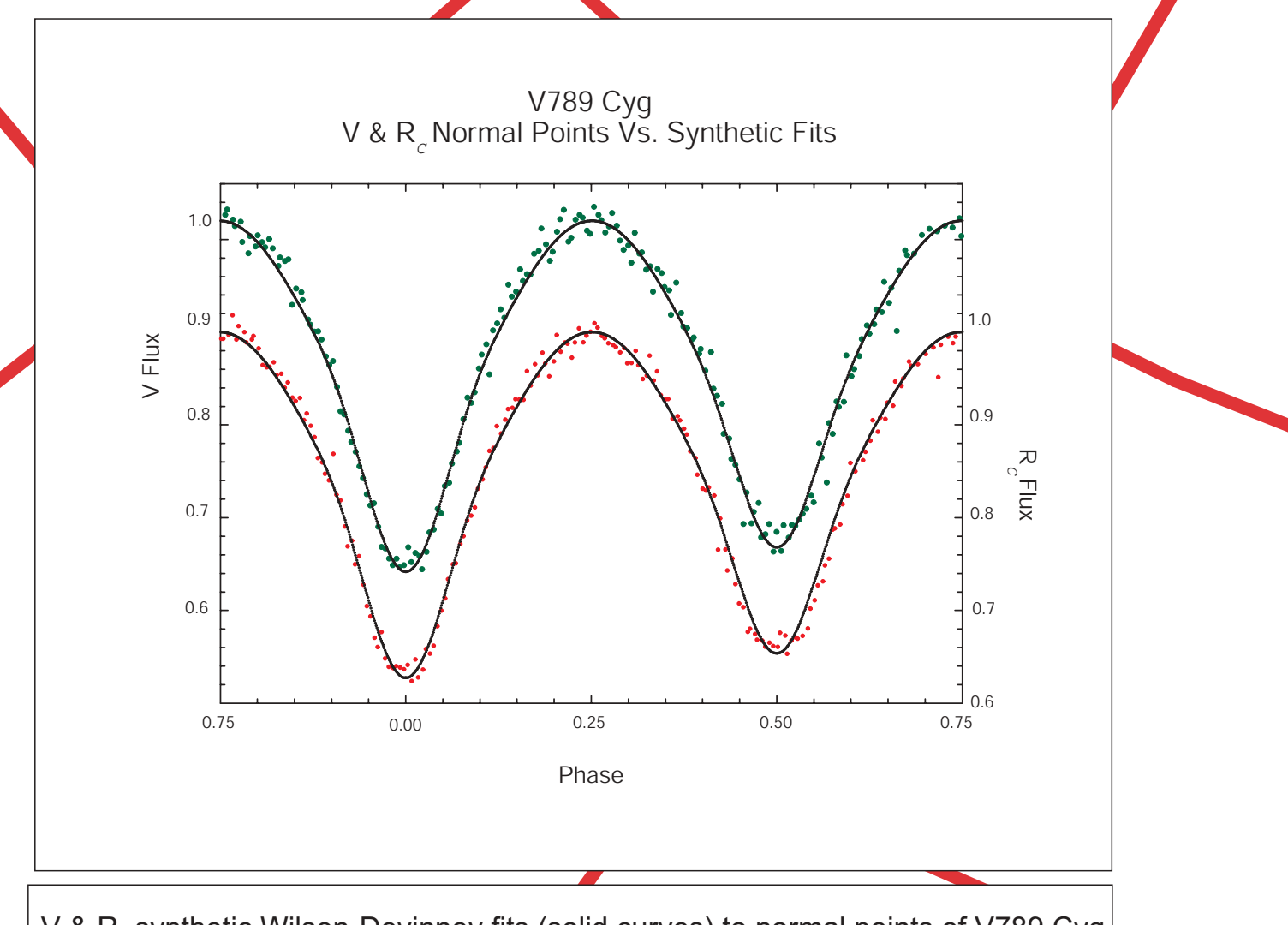
Latitude	Longitude	Radius	Temperature Factor
45°0'	260°0'	10°0'	0.75



Quadratic fit to the O-C residuals of V608 Cas; the solid circles represent CCD timings.



Individual V (green dots) and R_c (red dots) observations of V789 Cyg



V & R_c synthetic Wilson-Devinney fits (solid curves) to normal points of V789 Cyg

Light Curve Parameters for V789 Cyg

(Probable errors given in parentheses)

mass ratio	= 1.164 (9)
$\Omega_1 = \Omega_2$	= 3.9305 (157)
fillout	= 0.1464
inclination	= 71°86' (20)
mean density ₁	= 0.773 g/cm ³
mean density ₂	= 0.516 g/cm ³
T ₁	= 5600° K (assumed)
T ₂	= 5635° K (3)
albedo ₁ = albedo ₂	= 0.5 (assumed)
luminosity ₁ = L ₁ (5500 Å)	= 0.4624 (317)
luminosity ₂ = L ₂ (5500 Å)	= 0.5376
limb darkening x ₁ = x ₂ (5500 Å)	= 0.573 (assumed)
luminosity ₁ = L ₁ (6400 Å)	= 0.4572 (297)
luminosity ₂ = L ₂ (6400 Å)	= 0.5428
limb darkening x ₁ = x ₂ (6400 Å)	= 0.491 (assumed)
gravity brightening g ₁ = g ₂	= 0.32 (assumed)

Stellar Radii

r _{1, back}	= 0.40849 (712)	r _{2, back}	= 0.43499 (286)
r _{1, side}	= 0.37176 (442)	r _{2, side}	= 0.39987 (164)
r _{1, pole}	= 0.35300 (348)	r _{2, pole}	= 0.37627 (121)

