New Light Curves and Analyses of the Overcontact Binaries PP Lac and DK Sge

The Bradstreet Observatory at Eastern University

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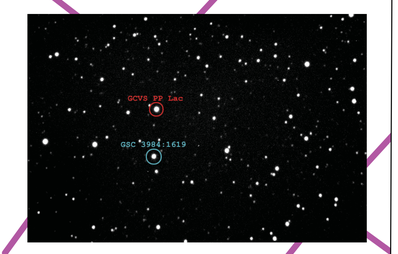
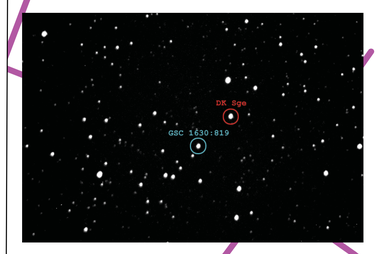


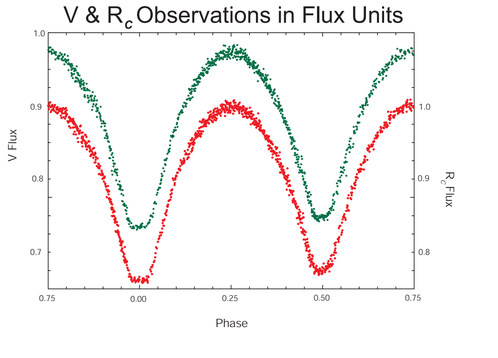


As a by-product of the ongoing work with the **C**atalog and **At**L**a**s of **E**clipsing **B**inaries database (**CALEB**; Bradstreet et al. 2004), several hundred eclipsing binary systems have been identified that have either unpublished or poor quality light curves. We present new *V* & R_C light curves for the overcontact systems PP Lac and DK Sge, both chosen because their reported deep eclipses (peak-to-peak amplitudes of nearly 0.7 mag) promised to help constrain the light curve modelling. Data were obtained using the 41-cm telescope at the Eastern University Observatory equipped with an SBIG ST-10XME CCD.

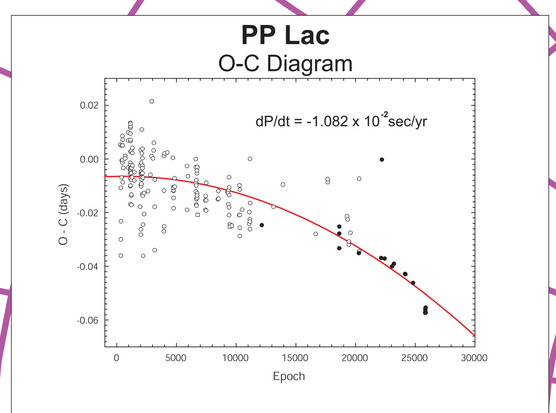
PP Lac (P= 0.40116 d) is a W-type contact binary with only one previously published light curve (Dumont & Maraziti 1990), but their data are sparse and almost non-existent at primary eclipse. Modelling of these data gave varying results; the published mass ratios differ by nearly 0.3. Our data confirms the noted differing eclipse depths but we find the primary eclipse to be total. PP Lac was observed from 13 September 2004 through 3 October 2004, resulting in 1054 observations in *V* and 1099 in R_C. These data were binned into 200 normal points in flux units and analyzed using ***Binary Maker 3*** (Bradstreet & Steelman 2002) and Wilson-Devinney (1971,1979,1992). The mass ratio was well-constrained by the duration of total eclipse and excellent fits were achieved. Our results are in between those published by Gaspani (1990) and Al-Naimiy & Al-Hindawy (1992). However, these previous analyses used the only existing published light curve of PP Lac which had large scatter as well as incomplete phase coverage. The parameters for the system are given in the table below. Analysis of the O-C diagram of PP Lac revealed a period decrease of -1.082 x 10^{-2} sec/yr and is shown below.

DK Sge (P=0.62182 d) appears to be an A-type contact binary with no published light curve. The eclipses are partial, with the primary eclipse being deeper by about 0.08 mag. The maxima show evidence of a significant asymmetry, especially in the *V* bandpass. The asymmetry in the light curve persisted over the 1 month of observations. DK Sge was observed from 31 August 2004 through 30 September 2004, resulting in 784 observations in *V* and 765 in R_C. These data were binned into 200 normal points in flux units and analyzed similarly to PP Lac. Due to the large asymmetry in the light curves, only the normal points from 0.00P to 0.50P were subjected to the final analysis by differential corrections because this section of the light curves seemed the least distorted. The distorted part of the light curves (from 0.50P to 0.00P) was manually modeled with two cool spots on the larger star. After many trials we were unable to simultaneously fit the *V* & R_C light curves with the same spot temperatures. The flux surpression in the *V* light curve was considerably greater than in R_C and when the *V* light curve was fit well, the synthetic R_C light curve was always much too deep. The model presented below was made to fit the R_C light curve, and the corresponding *V* synthetic curve can be seen to be too bright. Analysis of the O-C diagram of DK Sge revealed a period increase of +1.387 x 10^{-2} sec/yr and is shown below. Radial velocity curves for both of these systems are needed in order to calculate their absolute parameters.

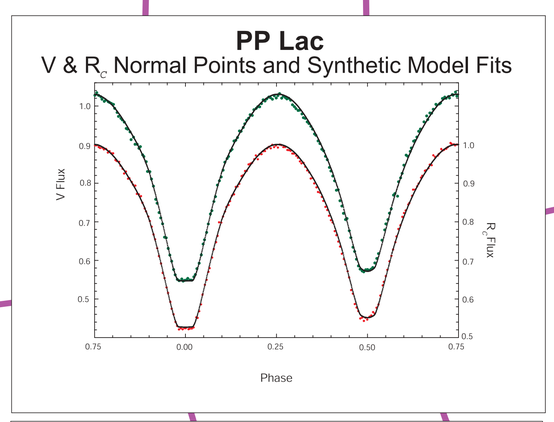
PP Lac



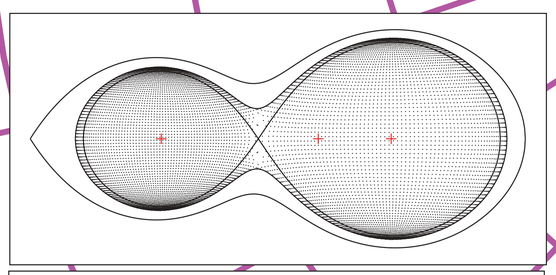
Individual V (green dots) and R_c (red dots) observations of PP Lac



Quadratic fit to the O-C residuals of PP Lac; open circles represent the visual timings, open squares the photographic timings and solid circles the CCD timings.

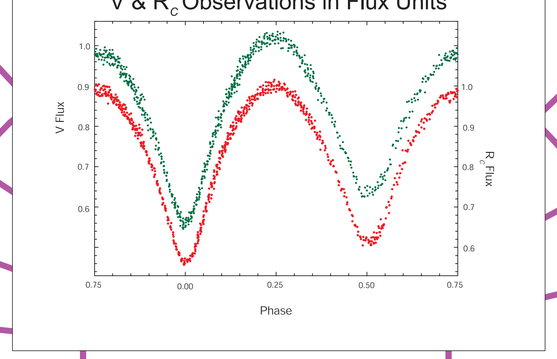


V & R_c synthetic Wilson-Devinney fits (solid curves) to normal points of PP Lac

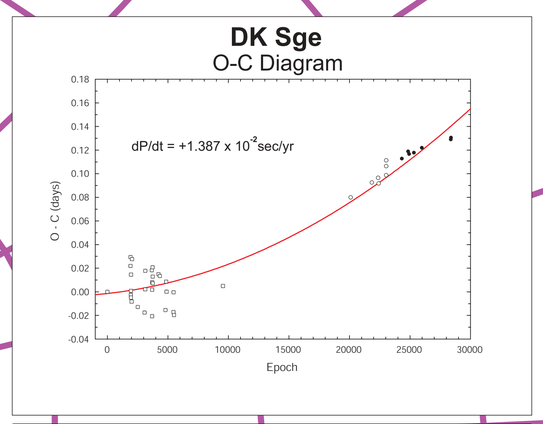


PP Lac with inner and outer Lagrangian surfaces

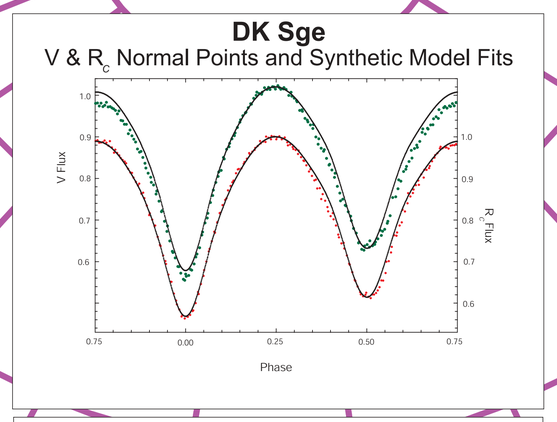
DK Sge



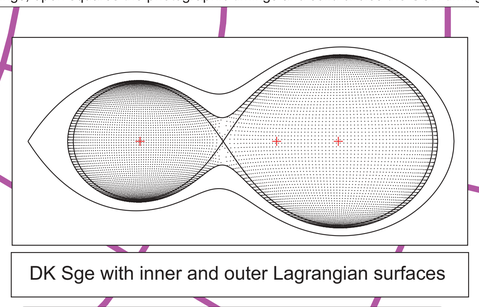
Individual V (green dots) and R_c (red dots) observations of DK Sge



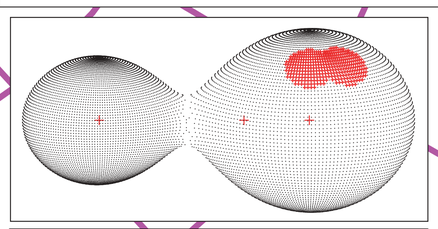
Quadratic fit to the O-C residuals of DK Sge; open circles represent the visual timings, open squares the photographic timings and solid circles the CCD timings.



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



DK Sge with inner and outer Lagrangian surfaces



DK Sge shown at 0.75P with cool spots

Light Curve Parameters for PP Lac

(Probable errors given in parentheses)

mass ratio	= 2.1526 (67)
$\Omega_1 = \Omega_2$	= 5.2657 (90)
fillout	= 0.3333
inclination	= 86°.86 (17)
mean density$_1$	= 0.4184 g/cm^3
mean density$_2$	= 0.3277 g/cm^3
T_1	= 6800°K (assumed)
T_2	= 6509°K (4)
albedo$_1$ = albedo$_2$	= 0.50 (assumed)
luminosity$_1$ = L_1(6400 Å)	= 0.3729 (17)
luminosity$_2$ = L_2(6400 Å)	= 0.6271
limb darkening $x_1 = x_2$ = (6400 Å)	= 0.428 (assumed)
luminosity$_1$ = L_1(5500 Å)	= 0.3782 (18)
luminosity$_2$ = L_2(5500 Å)	= 0.6218
limb darkening $x_1 = x_2$ = (5500 Å)	= 0.511 (assumed)
gravity brightening $g_1 = g_2$	= 0.32 (assumed)

Stellar Radii

r_1 back	= 0.37406 (257)	r_2 back	= 0.50374 (60)
r_1 side	= 0.32778 (135)	r_2 side	= 0.46898 (34)
r_1 pole	= 0.31148 (108)	r_2 pole	= 0.43702 (23)

Light Curve Parameters for DK Sge

(Probable errors given in parentheses)

mass ratio	= 0.4515 (52)
$\Omega_1 = \Omega_2$	= 2.7047 (103)
fillout	= 0.2816
inclination	= 79°.39 (28)
mean density$_1$	= 0.3312 g/cm^3
mean density$_2$	= 0.4301 g/cm^3
T_1	= 7000°K (assumed)
T_2	= 6668°K (12)
albedo$_1$ = albedo$_2$	= 0.50 (assumed)
luminosity$_1$ = L_1(6400 Å)	= 0.7046 (35)
luminosity$_2$ = L_2(6400 Å)	= 0.2954
limb darkening $x_1 = x_2$ = (6400 Å)	= 0.416 (assumed)
luminosity$_1$ = L_1(5500 Å)	= 0.7096 (35)
luminosity$_2$ = L_2(5500 Å)	= 0.2904
limb darkening $x_1 = x_2$ = (5500 Å)	= 0.497 (assumed)
gravity brightening $g_1 = g_2$	= 0.32 (assumed)

Stellar Radii

r_1 back	= 0.50116 (599)	r_2 back	= 0.36534 (647)
r_1 side	= 0.46799 (406)	r_2 side	= 0.32172 (320)
r_1 pole	= 0.43651 (294)	r_2 pole	= 0.30625 (250)

Spot Parameters on Star 1

Latitude	Longitude	Radius	Temperature Factor
45°.0	120°.0	15°.0	0.95
45°.0	90°.0	15°.0	0.95