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CCD PHOTOMETRY OF THE VARIABLE STARS V882 Her, V386 Vul AND LX Peg

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Observed star(s):				
Star name	GCVS type	Coordinates (J2000) RA	Dec	Comp./check star(s)
V882 Her	RRc	$17^h44^m49^s.1$	$+28°01'00''.$	CTI catalog
V386 Vul	RRc	$21^h21^m42^s.8$	$+28°09'06''.$	CTI catalog
LX Peg	EW	$22^h03^m18^s.9$	$+28°02'42''.$	CTI catalog

Observatory and telescope:
CCD Transit Instrument (CTI), 1.8-m f/2.2 meridian pointing telescope Capilla Peak Observatory (CAP), 0.61-m f/15.2 Cassegrain telescope US Air Force Academy Observatory (AFA), 0.61-m f/15.6 Cassegrain telescope

Detector:	CTI: RCA LN2-cooled CCD, 320 × 512 pixels, 8.3′ wide strip, CAP: RCA LN2-cooled CCD, 320 × 512 pixels, 3.6′ × 5.2′ FOV, AFA: Photometrics LN2-cooled CCD, 512 × 512 pixels, 3.6′ × 3.6′ FOV.

Filter(s):	CTI: BVR, CAP: V, AFA: BV

Date(s) of the observation(s):
CTI: 1988.04–1991.05, CAP: 1994.06–1995.11, AFA: 1998.06–2003.09

Photometric characteristics for these stars are listed in Table 1: $V_{\rm Max}$ and $V_{\rm Min}$ are the average standard V magnitudes at maximum and minimum light (CAP and AFA magnitudes transformed to CTI instrumental magnitudes via differential photometry with nearby stars in CTI database and then to standard magnitudes as detailed in Wetterer et al. 1996 - hereafter W96); $V_{\rm Mean}$ is the flux averaged standard V magnitude; $(B-V)$ is the B-V color (recalculated from CTI data for V882 Her (at minimum light) and V386 Vul (at maximum light due to limited CTI B observations), and average value and recalculated with CTI and AFA data for LX Peg); $E(B-V)$ is reddening (from W96 as estimated from Burstein and Heiles 1982); period is in days, epoch is HJD of maxima for V882 Her and V386 Vul and HJD of primary minima for LX Peg.

Table 1: Photometric characteristics

	V882 Her	V386 Vul	LX Peg
$V_{\rm Max}$	15.507(8)	15.155(7)	13.868(3)
$V_{\rm Min}$	15.828(10)	15.598(13)	14.060(5) (primary)
			14.032(9) (secondary)
$V_{\rm Mean}$	15.659(3)	15.359(3)	13.945(1)
$(B-V)$	0.31(4)	0.176(15)	0.978(5)
$E(B-V)$	0.056	0.152	0.090
period	0.377501(8)	0.2452165(7)	0.279152(2)
epoch	2452833.786(9)	2451092.790(4)	2452589.6290(24)
type	RRc	RRc	EW

Notes on individual stars:

V882 Her was listed in W96 as a RR Lyrae type c variable star with a period of 0.377069 days, although it was noted that the 1990-1991 CTI data did not match well with the chosen period. The additional AFA V observations make it clear that V882 Her's period is changing. Unfortunately, due to the large gaps of time between the various sets of data and the fact that CTI makes only one observation per night, creating a standard O-C plot for this star is impossible due to cycle count ambiguities. Instead, we used Lafler and Kinman's method for determining periods (Lafler and Kinman 1965) on subsets of the data to determine acceptable periods and their errors. Figure 1 plots the best periods and periods for aliases that produce reasonable but inferior light curves as a function of central year for various subsets of the data (the x-axis error bar indicates the range of data used). No acceptable periods could be found using the ranges 1988 to $\geq$ 1990, $\leq$ 1991 to $\geq$ 1998, and $\leq$ 1994 to 2003. The simplest solution to building a composite lightcurve is to use three different periods covering 1988-1989, 1990-1994, and 1998-2003. Figure 2 plots V882 Her's lightcurve for these three periods and the composite lightcurve using each period over the applicable time. Accepting these best periods leads to an anomalously large average period change rate of $\beta = 37 \pm 8$ days/Myr (shown as a line in Figure 1). More observations are clearly needed over a longer time baseline to better quantify the period change.

V386 Vul was listed in W96 as a RR Lyrae type c variable star with a period of 0.325160 days, although because of the sidereal day aliasing of CTI observations, it was noted that other periods were possible. Combining the CTI and AFA V observations (there were no CAP observations) indicate that V386 Vul's period is indeed a sidereal day alias to the originally calculated period. The new period is 0.2452165 days and the lightcurve is plotted in Figure 3.

LX Peg was listed in W96 as a W UMa type eclipsing variable with a period of 0.279144 days, although it was noted that some data did not fit this period very well and several other short periods were equally possible. Additional CAP and AFA V observations confirm that the period is close to the originally published period, however, this additional data also indicates that LX Peg's period may be changing. Employing a similar strategy as with V882 Her yields: no acceptable periods using all the data, 0.279152 $\pm$ 0.000002 days using AFA V data, and 0.279142 $\pm$ 0.000002 days using CTI and CAP V data. As in W96, the CTI and CAP period solution is marginal with some

data not fitting well. Further subdividing of the data, however, is not practical. Figure 4 plots LX Peg's lightcurve for these two periods and a composite lightcurve using each period with the applicable data. More observations over a longer time baseline are needed to better quantify the possible period change. New AFA B observations were made to check the B-V color and the B amplitude of variation. This was done to confirm LX Peg is too red to be a pulsational variable of the δ Sct type. A few of the AFA nights included enough phase coverage to measure minima timings for LX Peg using the Kwee and Van Woerden method (Kwee and Van Woerden 1956). These timings are listed in Table 2.

Table 2: LX Peg minima timings

HJD	type
2451041.874(6)	secondary
2451048.709(6)	primary
2451048.850(5)	secondary
2451082.771(13)	primary
2451092.739(8)	secondary
2452589.6290(24)	primary

Acknowledgements:
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References:

Burstein, D., and Heiles, C., 1982, *AJ*, 87, 1165.
Kwee, K. and Van Woerden, H., 1956, *BAN*, 12, 327.
Lafler, J. and Kinman, T. 1965, *ApJ Sup.*, 11, 216.
Wetterer, C.J., McGraw, J.T., Hess T.R., and Grashuis, R., 1996, *AJ*, 112, 742.

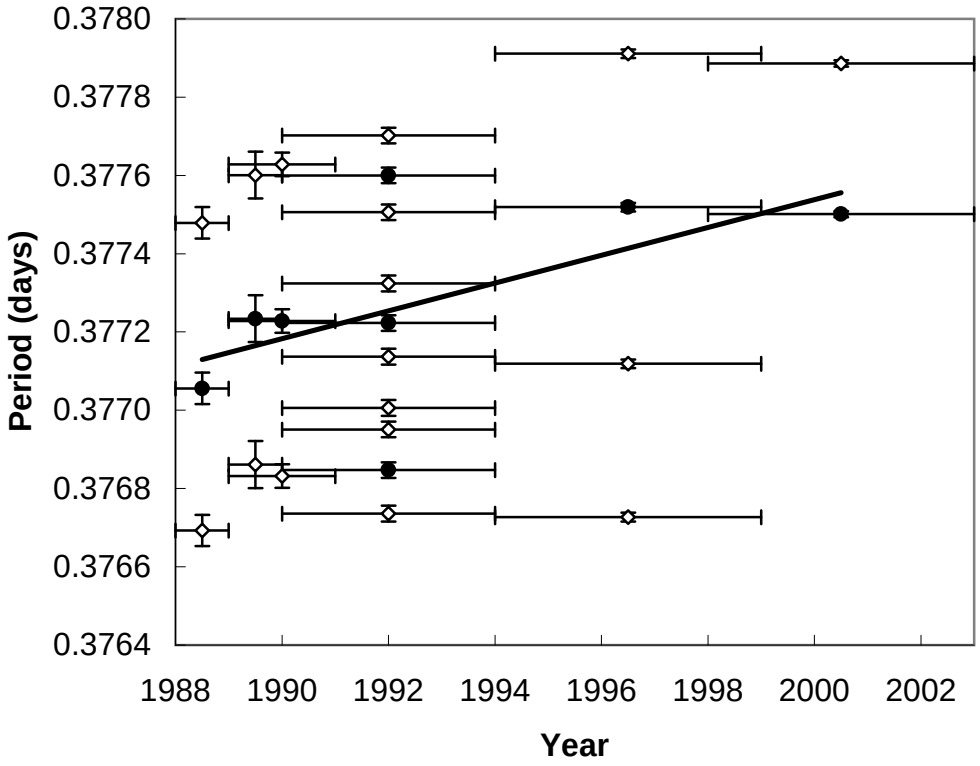

Figure 1. Calculated periods for V882 Her in days as a function of year. Filled diamonds are best periods, open diamonds are aliased periods that produce inferior light curves.

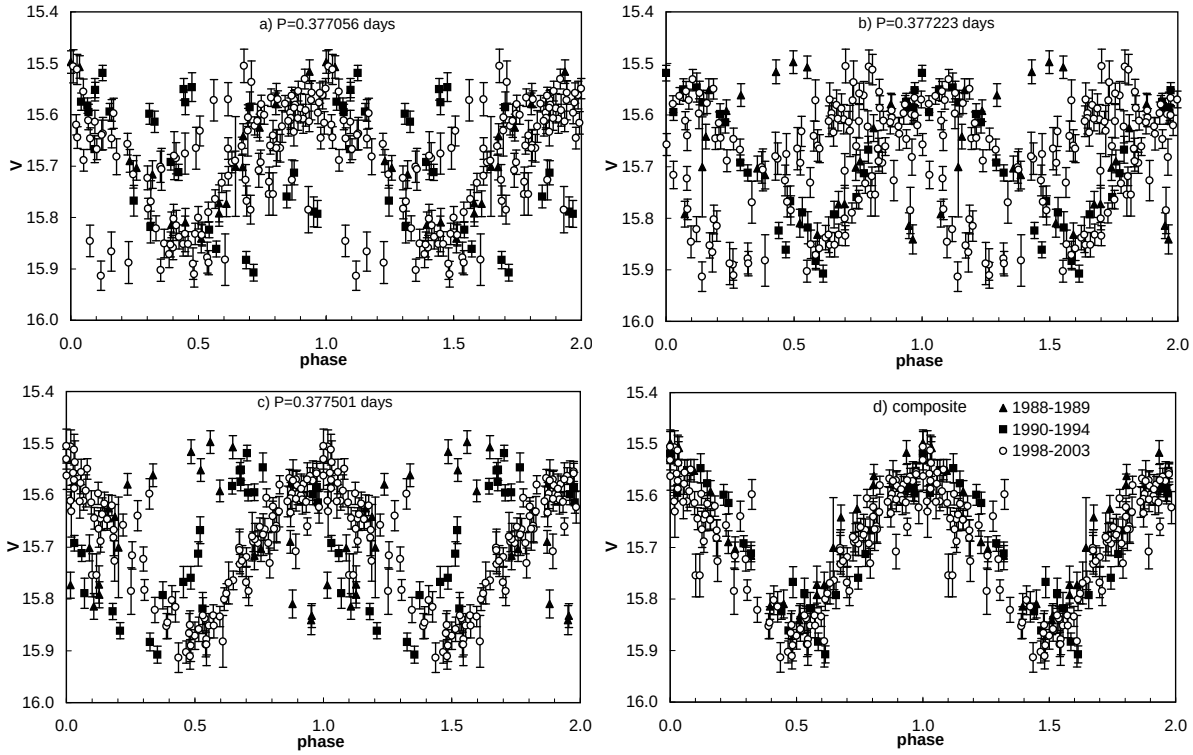

Figure 2. Light curves for V882 Her using various periods. Composite light curve uses - 1988-1989: P = 0.377056 days, epoch = 2447319.8405 HJD; 1990-1994: P = 0.377223 days, epoch = 2449552.8130 HJD; 1998-2003: P = 0.377501 days, epoch = 2452833.7863 HJD

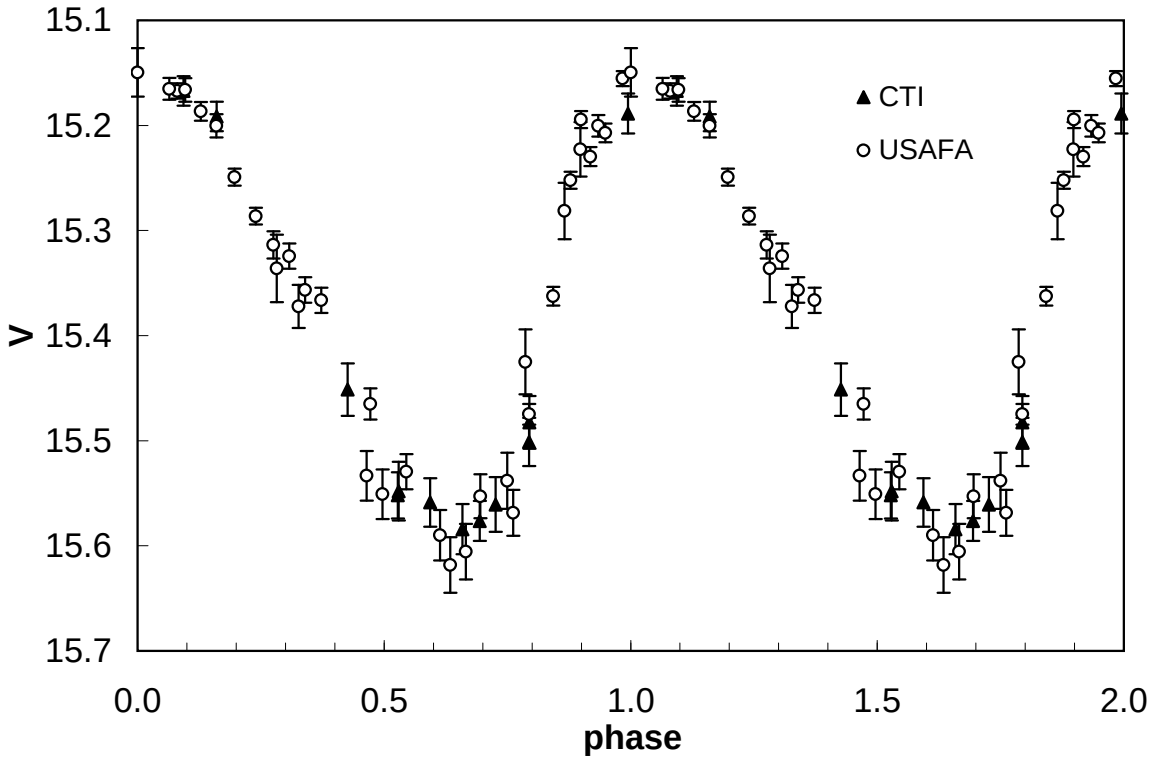

Figure 3. Ligh tcurve for V386 Vul: P = 0.2452165 days, epoch = 2451092.790 HJD

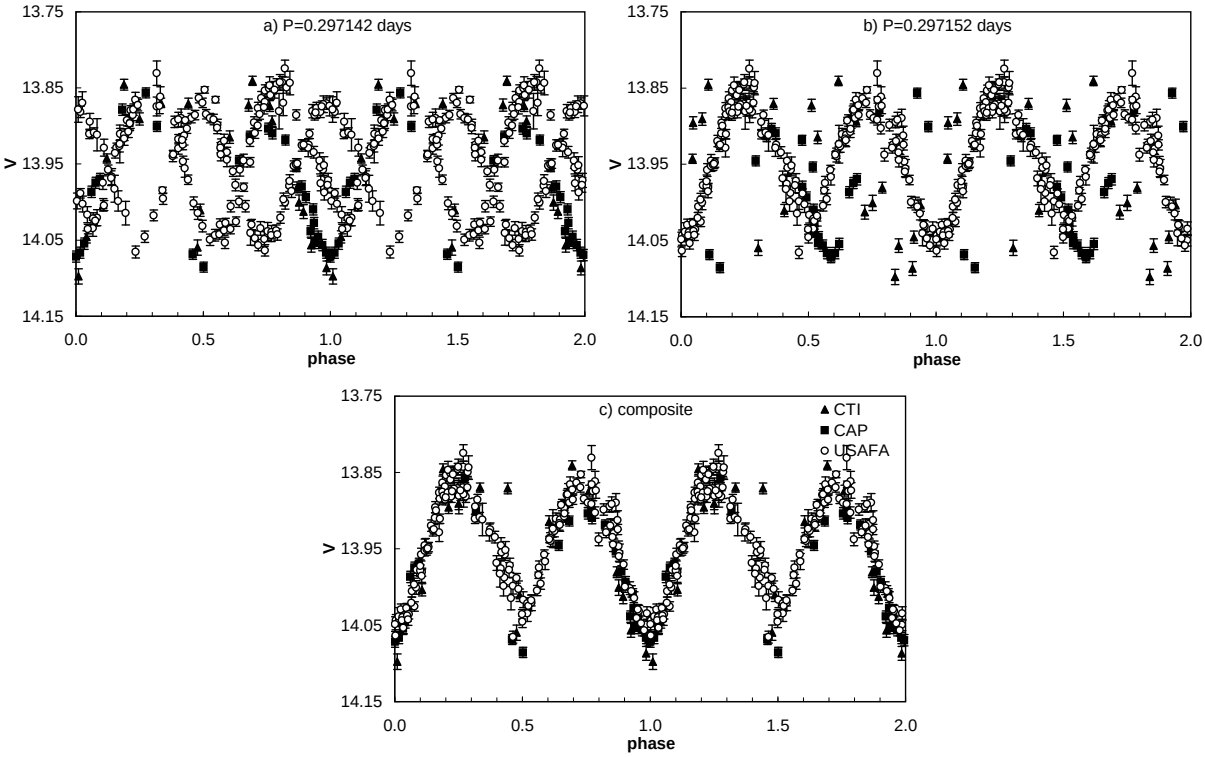

Figure 4. Light curves for LX Peg using various periods. Composite light curve uses - CTI/CAP: P = 0.279142 days, epoch = 2450036.670 HJD; AFA: P = 0.279152 days, epoch = 2452589.630 HJD