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LIGHT CURVE VARIABILITY IN XZ CANIS MINORIS

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XZ CMi is a short-period Algol that has previously been observed by Wilson (1966) and Terrell, Gunn, and Kaiser (1994; hereafter TGK) in the B and V passbands. In hopes of determining better system parameters and exploring the possibility of third light in the system as claimed by Rafert (1990), we decided to obtain $UBVR_cI_c$ photometry during the 2001-2002 observing season. XZ CMi was observed in the V passband from December, 2001 with the 24" telescope and ST-8 CCD at Sommers-Bausch Observatory (SBO) on the University of Colorado campus. The observation continued with the USNOFS 1.0m telescope and SITe CCD from February, 2002 and complete $UBVR_cI_c$ light curves were obtained.

Rafert (1990) used the Wilson-Devinney program (WD; Wilson and Devinney, 1971; Wilson, 1979) to fit the Wilson (1966) light curves. He found that third light in the amounts of 17% in V and 11% in B yielded better fits to the data than zero third light. On the other hand, Terrell and Wilson (1990) and TGK found acceptable fits without third light. Clearly the third light hypothesis was not strongly tested with data available in these previous studies. Based on our new observations, we can now state that third light was definitely present in these previous datasets. Figure 1 shows part of an I_c band image taken by Henden and clearly shows a visual companion 2.4" east and 0.5" south of XZ CMi.

Henden performed PSF-fitting to images taken on a night of relatively good seeing to measure the positions and colors of XZ CMi and the companion star. The data are listed in Table 1. Astrometry is based on the USNO-A 2.0 catalog and has less than 100 mas internal errors. The photometry has errors of 0.01 magnitudes or less. More complete photometric information about all stars within 5 arcmin of the variable can be found in file 5310-t3.txt at the IBVS web site.

Table 1. Standard magnitudes and color indices

Star	RA (J2000)	Dec (J2000)	V	$B-V$	$U-B$	$V-R_c$	R_c-I_c
XZ CMi	07:54:07.09	+03:39:20.6	10.122	0.371	−0.043	0.197	0.259
Companion	07:54:07.24	+03:39:20.1	12.097	0.663		0.416	0.404

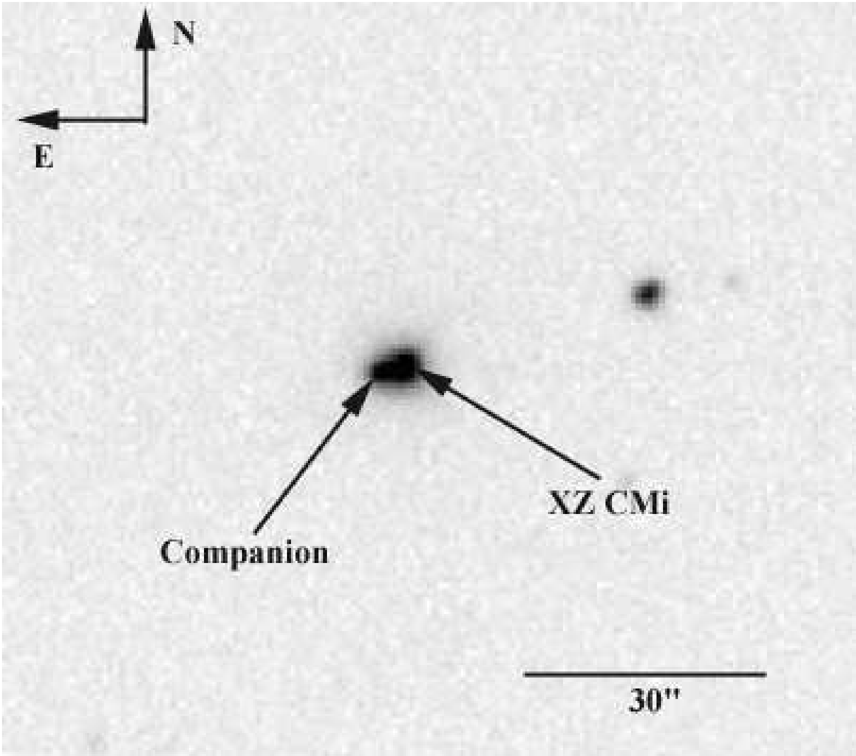

Figure 1. I-band image showing the fainter companion of XZ CMi.

As previously noted, our two datasets were obtained about two months apart. During that time the V light curve of XZ CMi changed noticeably. The SBO data show a mild asymmetry of about 0.01 magnitudes in the two maxima, with the maximum following secondary eclipse (i.e. phase 0.75) being the dimmer. By the time of the USNO observations, the asymmetry had grown to about 0.05 magnitudes. Previous datasets (Wilson, 1966 and TGK) were of lower precision but showed indications of slightly asymmetric maxima. Figure 2 shows our two V datasets. It is clear that the asymmetry in the light curves is affecting the maximum following secondary eclipse since the minima and the maximum following primary eclipse of the two datasets match up well. The most likely explanation for the asymmetries is the presence of large spots on the secondary star as is common in rapidly rotating stars with convective envelopes.

We performed a solution to our V observations using an unreleased version of the WD program that uses Kurucz atmosphere models to model the radiation of the stars. We used only data unaffected by the asymmetries, specifically data from phases 0.95 to 0.55. Because the most recently published ephemeris for the system (TGK) was obviously not valid for the current epoch, we adjusted the period and heliocentric Julian date of the primary minimum in our least squares fits. The fits were done in WD mode 5 which constrains the secondary star to fill its Roche lobe. Both of our datasets were obtained using aperture photometry and included the light of the companion star, so we fixed the third light to be 15% of the total system light at phase 0.25, based on the results of our PSF fits.

There has been some disagreement about the spectral type of XZ CMi. The GCVS lists it as F0 but Wilson (1966) argued that his photometry supported an A5 classification. Our photometry during secondary eclipse indicates a spectral type of about F2. Accordingly,

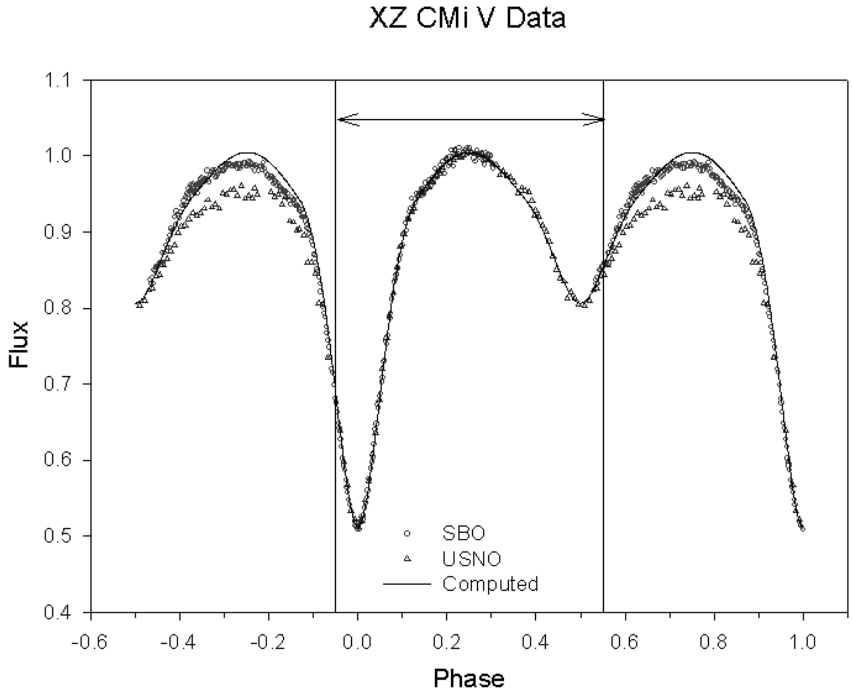

Figure 2. V light curves of XZ CMi. The arrows and vertical lines indicate the range of data used in the Wilson-Devinney solution.

we set T_1 to 7000 K in our solution. Unadjusted parameters such as the gravity darkening exponent and bolometric albedo were set to their theoretically expected values assuming that the envelope of the primary star was radiative and the secondary's was convective. The logarithmic limb darkening law was used with coefficients interpolated from the Van Hamme (1993) tables.

Table 2. Adjusted Parameters for Light Curve Solution

Parameter	Value	Std. Error
i	78°.8	0°.2
T_2	4910 K	20 K
q	0.68	0.02
Ω_1	3.48	0.04
$L_1/(L_1+L_2)_V$	0.85	0.05
HJD_0	2451957.6748	0.0011
P	0.d578852	0.d000002

Table 2 shows the results of our WD solution. The errors are the standard errors (1σ) from the least squares solution. The main differences between our solution and that of TGK are the higher mass ratio (0.68 versus 0.42) and a lower luminosity ratio (0.85 versus 0.92). A slight difference in the luminosity ratio is not surprising since the version of WD used by TGK used monochromatic effective wavelengths whereas the newer version that we employed uses actual filter bandpasses, and we included third light while TGK did not. The difference in the mass ratios is more troubling, an indication that perhaps the photometric mass ratio is not well-determined in this partially eclipsing system. We hope to obtain radial velocities of the system, as well as further photometry, during the next observing season.

The period derived from our light curve solution, 0.578852 days, is significantly larger than that found by TGK, 0.578809 days, and by Wilson (1966), 0.578811 days. Period changes are not unexpected since XZ CMi is semidetached and shows signs of large-scale magnetic activity. We encourage observers to measure frequent times of minimum to help characterize the nature of the period changes during this period of apparently heightened activity.

The SBO data are available from the IBVS web site as 5310-t4.txt and the USNO data are available as file 5310-t5.txt.

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