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PHOTOMETRY OF THE FAINT DWARF NOVA UZ SERPENTIS: DETECTION OF THE ORBITAL PERIOD [1]

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RESUMEN

La fotometría fotoeléctrica de la nova enana UZ Serpentis, obtenida durante tres días seguidos alrededor del mínimo, muestra una modulación orbital con un período de 0.1730 días. La curva de luz en *V* presenta variaciones sinusoidales con una amplitud de 0.26 mag, mientras que a longitudes de onda correspondientes al *B* tienen una amplitud mayor de 0.4 mag. Las curvas de luz pueden ser explicadas en términos de la contribución asimétrica del *punto caliente* en las partes externas del disco de acreción.

ABSTRACT

Photometry of the dwarf nova UZ Serpentis, obtained during three consecutive days near minimun, shows an orbital modulation with a period of 0.1730 days. The *V* light curve presents sinusoidal variations with an amplitude of 0.26 mag, while at *B* wavelengths they have a larger amplitude of 0.4 mag. The light curves can be explained based on the asymmetric contribution of the hot spot in the outer parts of the accretion disc.

Key words: **STARS-BINARIES – STARS-CATACLISMIC – STARS-DWARF NOVAE – STARS-PHOTOMETRY**

I. INTRODUCTION

Dwarf Novae are a group of interactive binaries belonging to the Cataclysmic Variable group. They are semidetached systems in which a red dwarf secondary overflows its matter, through the inner Lagrangian point, into an accretion disc surrounding a white dwarf primary (Warner and Nather 1971). Although all well observed Cataclysmic Variables have proved to be binary stars, there are still a large number of objects with unknown orbital periods. Among these is the dwarf nova UZ Serpentis whose flux distribution has been thoroughly observed at minimum and maximum by Panek (1979), Echevarría *et al.* (1981) and Verbunt *et al.* (1984). Due to the faint magnitude of the object at minimum ($V \approx 16.2$), no radial velocity or light curves were available to date. For this reason UZ Ser was observed photoelectrically, in order to search for eclipses or orbital modulations. The positive results of the observations are presented in this paper.

II. OBSERVATIONS

Photoelectric photometry at *UBV* (Johnson) and *RI* (Kron-Cousins) wavelengths of UZ Ser was obtained on 1985 July 10 to 12, with the Pulse Counting Photometer No. 1, described by Echevarría *et al.* (1986), attached to the 2.12-m telescope of the Observatorio Astronómico Nacional at San Pedro Mártir, Baja California, México.

The acquisition software is designed to provide the observer with on-line statistics. For this purpose a basic real integration time of 1 sec is always used, and therefore any large integration time will be the sum of this integration module. When the observer completes a sequence of integrations the computer stores every integration module. A setback to this approach is that the system has a large 0.6 sec dead time between integrations.

Observations of UZ Ser started 6 days after the peak of the July 5 outburst, and ended 12 days before the July 24 outburst (Bortle 1986). *UBVRI* magnitudes were obtained at the beginning of each night. A diaphragm of 15 arcsec was used. The magnitudes are derived from the comparison star observed by Echevarría *et al.* (1981). From this material four light curves were obtained: one in *R*, one in *B*, and two in *V*. The *B* and *V* light curves obtained during the third night are quasi-simultaneous. The comparison star and the sky were monitored every 20 min approximately. The sky conditions during the first night were rather poor. The journal of observations is given in Table 1, while the *UBVRI* magnitudes are given in Table 2. The observed magnitudes indicate that the system was detected during late decline and early minimum.

III. REDUCTION OF THE DATA

The typical counts for UZ Ser in filter *V* were about

1. Based on observations collected at the Observatorio Astronómico Nacional of San Pedro Mártir, B.C., México.

TABLE 1

JOURNAL OF OBSERVATIONS FOR UZ SER

Date 1986	Start	Finish	Wavelengths
July 10	$6^h 40^m$	$10^h 07^m$	*UBVRI, R* Light Curve
July 11	$5^h 24^m$	$11^h 04^m$	*UBVRI, V* Light Curve
July 12	$4^h 48^m$	$11^h 00^m$	*UBVRI, B* and *V* Light Curves

TABLE 2

PHOTOMETRY OF UZ SER

JD 2440000+	*U*	*B*	*V*	*R*	*I*
6621.78	15.16	16.20	15.59	15.20	14.79
6622.73	15.21	16.20	15.60	15.05	14.45
6623.70	15.40	16.53	15.97	15.51	15.19

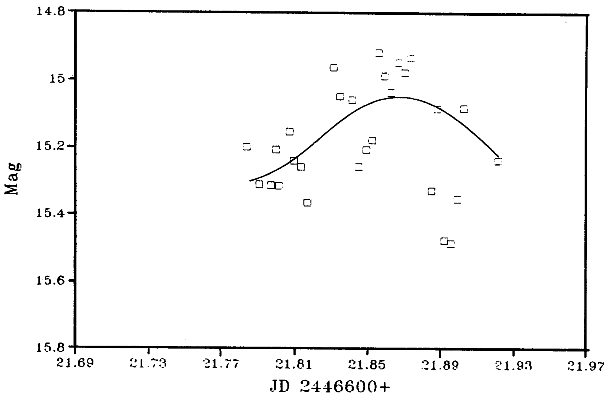

Fig. 1. *R* measurements of UZ Ser. The solid line is the fit based on the *V* light curves only.

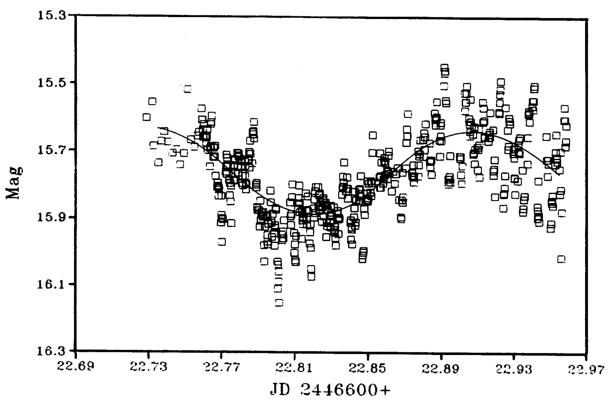

Fig. 2. *V* light curve of UZ Ser obtained during the second night. The solid line is the fit discussed in the text.

700 per second, while the sky counts were more numerous, around 3000 counts per second. For this reason, we took great care in the process to subtract the sky. The sky counts were plotted to search for uneven variations during the night. Since only smooth variations were found, an interpolated sky was subtracted. The data were corrected for atmospheric extinction with values derived from the comparison star. Standard errors for a 10 module integration are ±0.04 mag. Figure 1 shows the *R* light curve with a resolution of 120 module integrations, while Figures 2 to 4 show the *B* and *V* light curves with a resolution of 10 module integrations. The two *V* light curves, obtained during consecutive nights, have a similar appearance and will be the basis for our period estimate. The scatter in the figures is larger than the expected errors and may be attributed to flickering in the object, except for Figure 1 in which the scatter is probably due to the bad weather conditions. We have

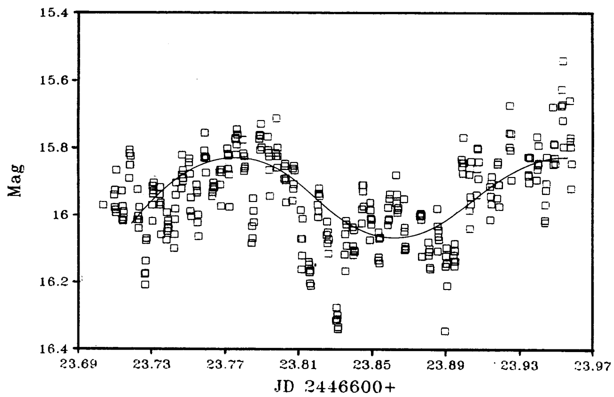

Fig. 3. *V* light curve of UZ Ser obtained during the third night. The solid line is the fit based on both *V* light curves.

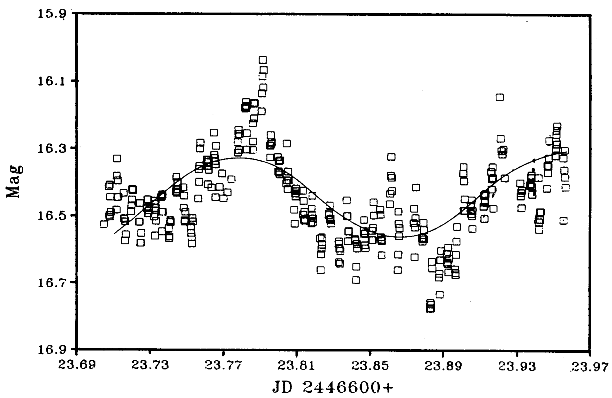

Fig. 4. *B* light curve of UZ Ser obtained simultaneously with the *V* light curve shown in Figure 3. The solid line is the fit based on Figures 2 and 3 only.

compared the quality of our light curves with those of Z Cam obtained by Robinson (1973) with a 2.08-m telescope and without any filter. Taking into account that the filters reduced the amount of available light, that Z Cam is about an order of magnitude brighter than UZ Ser, and that our object was observed through a large air mass (between 1.5 and 5 during a night), we should expect to do no much better in a northern observatory with our instrumental setup.

IV. THE ORBITAL PERIOD

The two V band light curves present a well defined slow modulation. A sinusoidal fit based on both nights is shown as a solid line, with a semiamplitude of 0.128 mag and given by the adopted ephemeris:

$$\mathrm{JD(min)} = 2446622.6480 + 0.1730\,E$$
$$\pm 0.0010 \quad \pm 0.0005 \quad .$$

This is the best fit which has the lowest error in the semiamplitude variation. Two other period aliases of 0.2120 and 0.1480 days were found, but their errors are greater than the 0.1730 day determination. Although the cycle counts allow for these periods, the R measurements (not taken into account to determine the period), have a maximum near the expected value from the adopted ephemeris. The solid line represent the sinusoidal fit, but has been shifted around the mean value to fit the R observations. It is possible that the orbital period is two times the calculated value (if, for example, the modulations were due to variations produced by ellipsoidal deformations of the secondary star). However, this is unlikely because at a period around 8.3 hours the secondary star should be clearly visible, contrary to the spectroscopic evidence by Verbunt *et al.* (1984). Furthermore, a large period is not compatible with the results derived from the decay-rate and orbital period correlation found by Bailey (1975) for which the linear part of the light curve during decline can be approximated by the relation t_d(days/mag) = 0.11 + 11.1P_{days} (Mattei and Klavetter, unpublished). The V band observations by Verbunt *et al.* give t_d = 1.61, yielding a period of 0.1351 days. Echevarría (1983) has also shown that the mean B-V and $U-B$ colours at minimum are correlated with period and can be approximated by the relations $(B-V) = -0.15 + 0.10P$ (hr) and $(U\text{-}B) = -1.33 + 0.09P$ (hr). Adopting $E(B-V) = 0.30$, $B-V = 0.52$ and U-B = −0.82 from Verbunt *et al.*, the reddening free indices $B-V = 0.22$ and $U-B = -1.04$ and periods $P_{B-V} = 3.7$ hr and $P_{U-B} = 3.2$ hr are obtained.

The V light curve presents sinusoidal variations with an amplitude of 0.26 mag, while at B wavelengths they have a larger amplitude of 0.4 mag. The light curve can be explained purely on the basis of a hot spot on the accretion disc. For moderate inclination angles of the accretion disc, the hot spot will contribute at all orbital phases, but it will be most conspicuous when facing the observer. Since there are no eclipses the orbital hump increases and decreases smoothly as the hot spot leaves the far side of the disc, faces the observer and goes back again. A larger amplitude through the B filter is also expected because of the high temperature of the hot spot. It is possible that the sinusoidal variations may be produced by the secondary star itself, if the surface facing the primary star is heated by radiation coming from the white dwarf or from the accretion disc. Radial velocity measurements will be needed to decide between these interpretations.

The scatter in the data limits any detailed interpretation. Better photometric observations should be made to obtain a model which may explain the light curves of this system. From San Pedro Mártir, however, UZ Ser has a maximum altitude of 40°. Southern observers are strongly encouraged to observe this object.

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REFERENCES

Bailey, J. 1975, *J. Br. Astr. Ass.*, **86**, 30.
Bortle, J.E. 1986, *Am. Asoc. Var. Star Observ.*, Circular No. 190.
Echevarría J. *et al.* 1981, *M.N.R.A.S.*, **197**, 565.
Echevarría, J. 1983, D. Phil. Thesis. University of Sussex.
Echevarría, J. *et al.* 1986, *Reporte Técnico No. 37*, Instituto de Astronomía, Universidad Nacional Autónoma de México.
Panek, R.J. 1979, *Ap. J.*, **234**, 1016.
Robinson, E. L. 1973, *Ap. J.*, **180**, 121.
Verbunt, F. *et al.* 1984, *M.N.R.A.S.*, **210**, 197.
Warner, B. and Nather, R.E. 1971, *M.N.R.A.S.*, **152**, 219.

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