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OBSERVATIONS OF SUPERHUMPS IN CY UMa

CY UMa was discovered as a dwarf nova by Goranskij (1977). Little attention had been paid until regular visual monitoring by VSOLJ members detected a long outburst in Jan. 1988 (Kato et al., 1988). From the analysis of visual and photographic light curve during this outburst, they detected a possible superhump period of 0.0593 day, and concluded that CY UMa belongs to SU UMa-type dwarf novae. Since this detection of superhumps was suspected to be severely affected by limits of accuracy of visual and photographic observations, the author has been trying to confirm superhumps of CY UMa by CCD photometry. The observations reported here were done during two long outbursts in Dec. 1991 – Jan. 1992 and in Mar. 1993.

The observations were carried out using a CCD camera (Thomson TH 7882, 576 × 384 pixels) attached to the Cassegrain focus of the 60 cm reflector (focal length=4.8 m) at Ouda Station, Kyoto University (Ohtani et al., 1992). To reduce the readout noise and dead time, an on-chip summation of 3×3 pixels to one pixel was adopted. An interference filter was used which had been designed to reproduce the Johnson V band. The exposure time was between 20 and 120 s depending on the observing condition. The frames were first corrected for standard de-biasing and flat fielding, and were then processed by a personal-computer-based aperture photometry package developed by the author. The differential magnitudes of the variable were determined against a local standard star GSC 3446.344 ($10^h57^m05\overset{s}{.}38$ $+49°37'30\overset{''}{.}4$ (J2000.0), V=12.9. The position and magnitude were taken from the Guide Star Catalog). The constancy of this comparison was checked against several stars in the same field.

The first outburst was covered from the terminal stage to its return to near quiescence (Figure 1). The Dec. 30 light curve (Figure 2) clearly shows superhumps with an amplitude of 0.18 mag. A period analysis of observations on Dec. 29–30 using the Phase Dispersion Minimization (PDM) method (Stellingwerf 1978), after heliocentric correction and removing a linear trend of decline, has yielded a superhump period of 0.0714 ± 0.0005 day. This observation clearly confirmed the SU UMa-type nature of CY UMa. Additional observations were performed on four nights from Jan. 1 through Jan. 4 just after the star returned to near quiescent brightness. A period analysis gives a theta diagram (Figure 3), which suggests persistence of the superhump period near P=0.0723 day and possible periodicity near 0.0678 day. Although irregular variation and relatively low signal-to-noise ratio have made these periods less confident, one may attribute the variability of the first period to late superhumps and the second possible orbital humps [however, one should note that the latter period may be affected by the one-day alias of the first period].

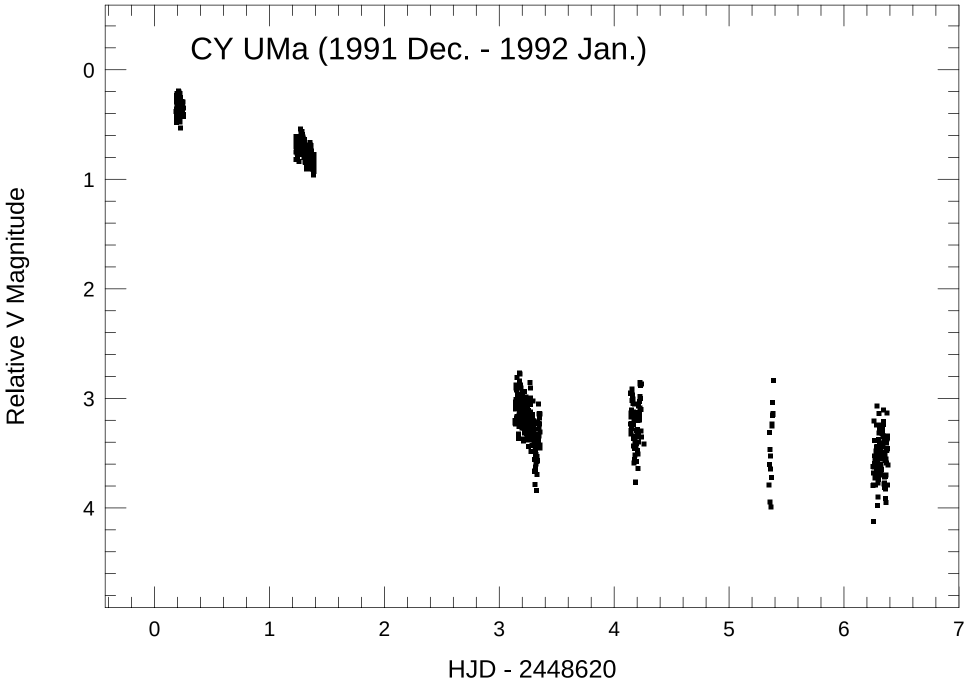

Figure 1. V-band light curve of CY UMa during a superoutburst in Dec. 1991–Jan. 1992. The zero point of the magnitude scale corresponds to V=12.9.

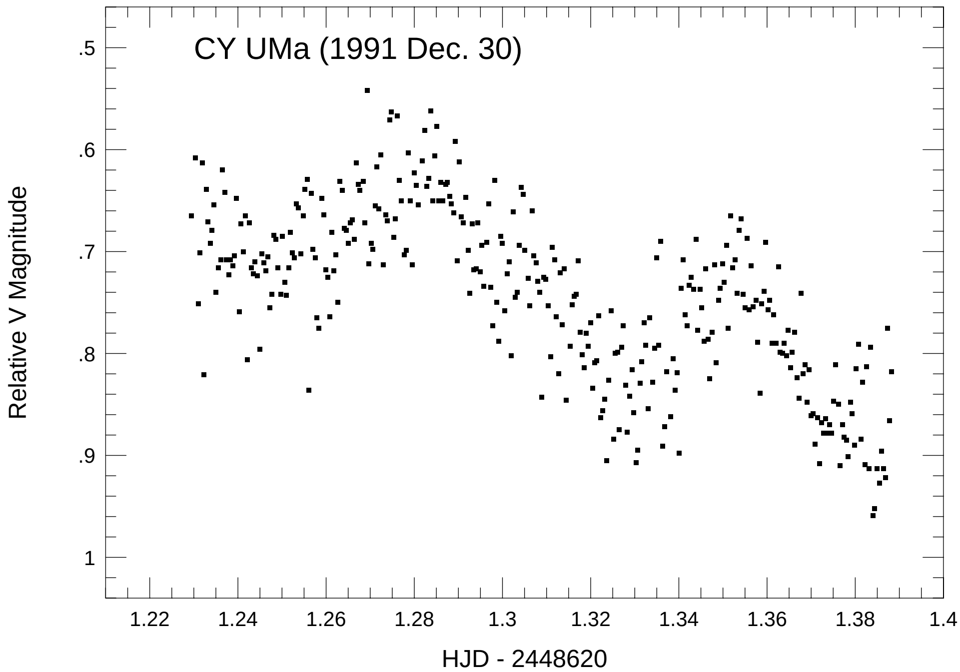

Figure 2. The light curve on Dec. 30, 1991. Superimposed on a slow decline, superhumps with an amplitude of 0.18 mag are clearly seen.

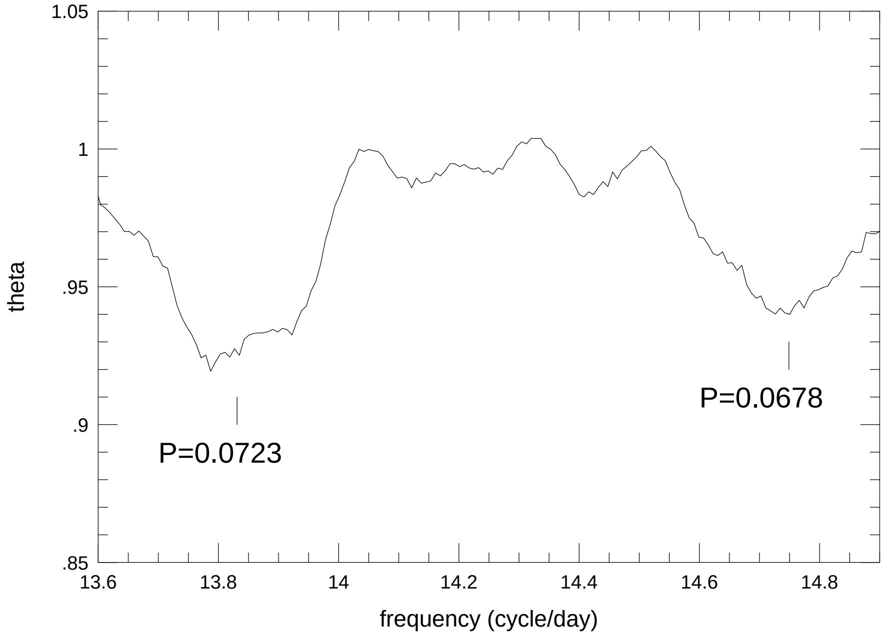

Figure 3. Theta diagram (Stellingwerf 1978) of period analysis for the post-outburst period Jan. 1–Jan. 4, 1991. Two minima in the theta diagram represent the periods of 0.0723 and 0.0678 day (see the text for interpretation).

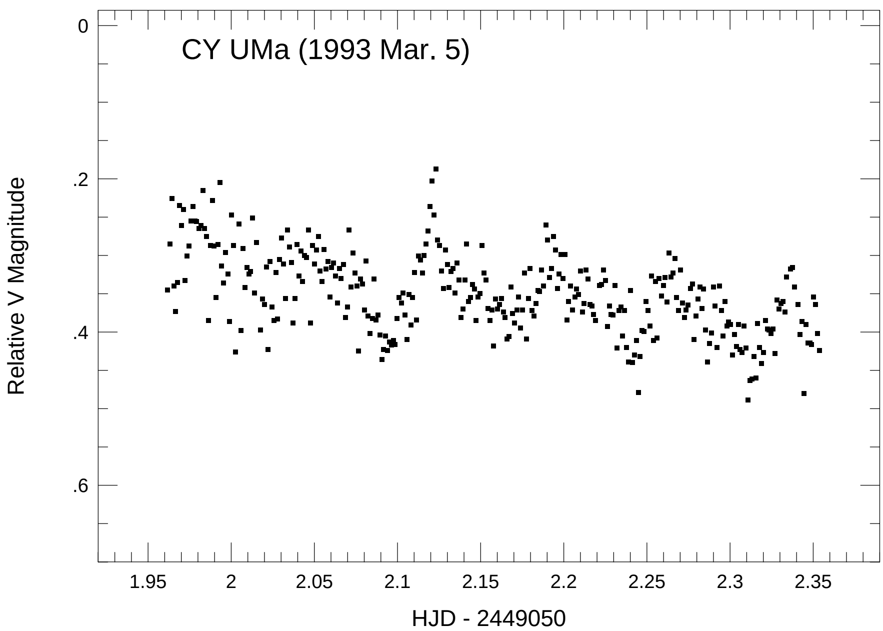

Figure 4. The light curve on Mar. 5, 1993 (second outburst). Doubly humped superhumps with a period of 0.0721 day are clearly seen.

The second outburst was followed on one night, Mar. 5, 1993. Doubly humped superhumps were clearly detected (Figure 4). A period analysis with the same procedure as in the first outburst has yielded a superhump period of 0.0721 ± 0.0003 day. A small difference of superhump periods obtained during two different superoutbursts may reflect intrinsic period variation of superhumps. From these observations we may safely conclude that the superhump period of CY UMa is 0.0719 ± 0.0005 day, which was later independently confirmed during the 1995 superoutburst by Harvey, Patterson (1995), who gave a period of 0.0724 ± 0.0005 day. The star was recently investigated by two groups based on radial velocity study; Martínez-Pais, Casares (1995) gave an orbital period of 0.06795 ± 0.00008 day, and Thorstensen (1995) 0.06957 ± 0.00004 day. The value of fractional superhump excess ($(P_{\rm SH}-P_{\rm orb})/P_{\rm orb}$) obtained by our superhump period seems to support the latter period, but near coincidence of the former period with one observed after the first outburst would require additional confirmation of the true orbital period.

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Taichi KATO
Kyoto University
Sakyo-ku, Kyoto 606-01 Japan

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