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PHOTOMETRIC DETECTION OF THE ORBITAL PERIOD IN ER UMa

ER UMa (=PG0943+521) is a prototype of recently discovered small group of SU UMa-type dwarf novae (ER UMa stars or RZ LMi stars) which are characterized by extremely short (19 – 44 d) interval (supercycle) between successive superoutbursts, short (3 – 4 d) outburst interval of normal outbursts, and small ($\sim$ 3 mag) outburst amplitude (Kato, Kunjaya 1995; Misselt, Shafter 1995; Robertson et al. 1995).

The classification of ER UMa stars as SU UMa-type dwarf novae was based on the detection of periodic modulations, which have been considered to be superhumps, during the long outbursts. However, there still remains some ambiguity of the identification of superhumps since two of three well-established ER UMa stars do not have published orbital periods. The first established member, ER UMa, is not an exception. An attempt to determine its orbital period seems to have been hindered by its seemingly low-inclination binary configuration (Ringwald 1993). The identification of superhumps in these systems has been therefore largely based on unstableness of the period, or loss of coherence between outbursts. Determination of orbital periods in these systems is therefore an urgent task in order to verify these identifications and interpretation of these systems. We here report on detection of periodic modulation in ER UMa during quiescence, whose period we attribute to its orbital period.

Observations were carried out on Jan. 19, 1995, when ER UMa was in quiescence between normal outbursts. We used a CCD camera (Thomson TH 7882, 576 $\times$ 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 2$\times$2 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 120 seconds. The reduction technique, the comparison and check stars are the same as described in Kato, Kunjaya (1995).

The resultant light curve is shown in Figure 1. ER UMa showed a slow increase in brightness by 0.2 mag during the seven hours' run. Superimposed on this linear trend, there existed a semi-periodic modulation with a typical amplitude of 0.3 – 0.4 mag. A period analysis using the Phase Dispersion Minimization (PDM) method (Stellingwerf 1978), after removing a linear increase of brightness, has yielded a theta diagram shown in Figure 2. The best frequency determined by the bisection method is 15.75 $\pm$ 0.04 cycle/day, corresponding to a period of 0.0635 $\pm$ 0.0002 day, which is considerably shorter than the published superhump periods of 0.06549 – 0.06573 day. From the facts that the observed period is about 3 percent shorter than the superhump period, and that the modulations were observed during quiescence, we have attributed this period as the orbital period of ER UMa. This identification seems to be consistent with the result of recent high accuracy radial velocity study by Thorstensen (1995), who gave a period of 0.06366 $\pm$ 0.00004 day.

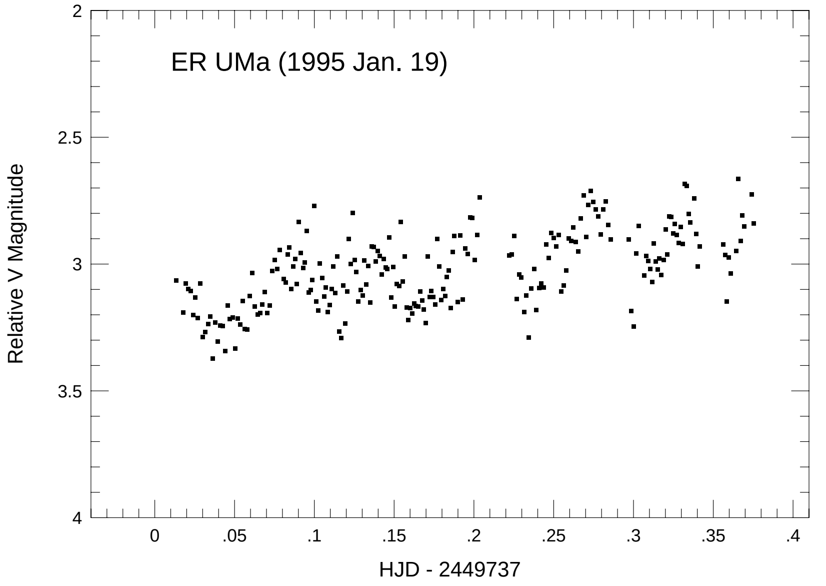

Figure. 1. *V*-band light curve of ER UMa obtained during quiescence (Jan. 19, 1995). The zero point of the magnitude scale corresponds to V=12.0. Superimposed on a gradual rise, semi- periodic oscillations with an amplitude of 0.3 – 0.4 mag and a period of 0.0635 day are clearly visible.

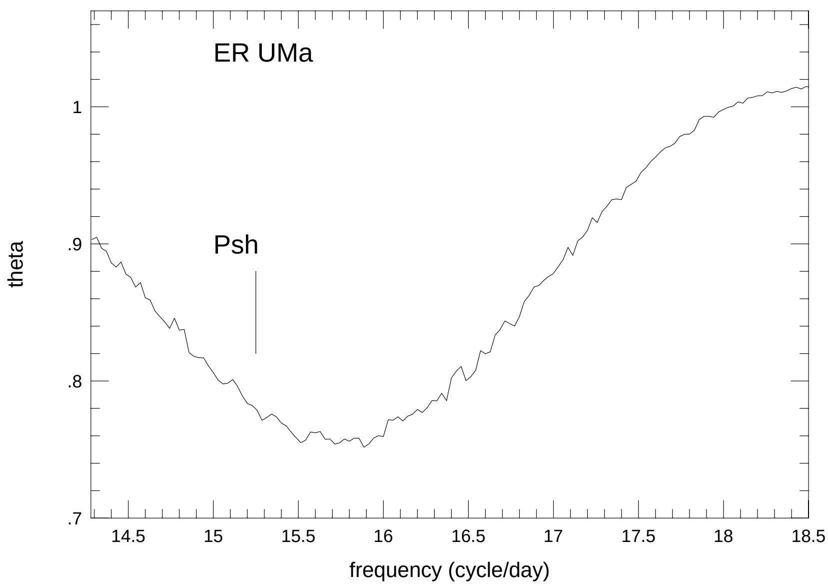

Figure. 2. Theta diagram (Stellingwerf 1978) of period analysis for the data in Figure 1. The most likely period is slightly offset to a higher frequency (shorter period) to the reported superhump period, which is marked as Psh in the figure.

Although the good agreement of the photometric and spectroscopic periods strongly supports that the periodic modulation detected here is related to the orbital motion, the low inclination configuration proposed by Ringwald (1993) poses a problem in interpreting the source of light modulation. It would be unlikely that the modulation is caused by geometric obscuration of the hot spot as in high inclination systems. Under the restriction of this configuration, we may propose a possibility of changing release of potential energy of accretion stream hitting a non-precessing eccentric accretion disk. This interpretation should be tested by future observations.

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Taichi KATO,
Seiji MASUDA,
Daisaku NOGAMI
Kyoto University
Sakyo-ku, Kyoto 606-01 Japan

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