COMMISSIONS 27 AND 42 OF THE IAU
INFORMATION BULLETIN ON VARIABLE STARS

Number 5268

Konkoly Observatory
Budapest
1 May 2002

HU ISSN 0374 – 0676

OUTBURST PHOTOMETRY OF EY Cyg

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EY Cyg is a well-known dwarf nova with a very long cycle length. In spite of its relatively bright magnitude (V $\sim 11.^{m}4$ at maximum, V $\sim 15.^{m}5$ at minimum), no time-resolved CCD or photoelectric photometry has been yet published. We observed EY Cyg on two outburst occasions in 1992 and 2001. Between these outbursts, only one additional outburst (1997 January) is known, which was poorly observed because of the unfavorable seasonal condition.

The 1992 observations were done on three nights between April 5 and 11, using a CCD camera (Thomson TH 7882, 576 × 384 pixels, on-chip 3 × 3 binding adopted) attached to the Cassegrain focus of the 60 cm reflector (focal length=4.8 m) at Ouda Station, Kyoto University (Ohtani et al. 1992). An interference filter was used which had been designed to reproduce the Johnson V band. The exposure time was 20–40 s depending on the transparency. The 2001 observations were done on 12 nights between November 15 and December 4, using an unfiltered ST-7E CCD camera attached to a Meade 25-cm Schmidt-Cassegrain telescope, located in Kyoto University. The exposure time was 30 s. The frames were first corrected for standard de-biasing (Ouda data) or dark subtraction (Kyoto data) and flat-fielding, and were then processed by a microcomputer-based aperture photometry package (Ouda data) or Java$^{\rm TM}$-based aperture photometry package developed by one of the authors (TK). We used two comparison stars GSC 2673.525 (Tycho-2 magnitude $V{=}10.^{m}89 \pm 0.^{m}06$, $B-V{=}+0.^{m}46 \pm 0.^{m}08$) and GSC 2673.2950 (Tycho-2 magnitude $V{=}11.^{m}47 \pm 0.^{m}10$, $B-V{=}+0.^{m}31 \pm 0.^{m}14$), whose constancy during the run was confirmed by inter-comparison. The magnitudes of EY Cyg were determined relative to the sum of these two stars (Ouda data) or relative to GSC 2673.525 (Kyoto data). Barycentric corrections to observed times were applied before the following analysis. Table 1 lists the log of observations, together with nightly averaged magnitudes.

Figure 1 shows the light curves of the 1992 and 2001 outbursts drawn from nightly averaged magnitudes by this study. Both sets of observations covered the decline from outbursts. The object showed on both occasions a linear fading at a rate of 0.30 mag d^{-1} (1992) or 0.28 mag d^{-1} (2001) for the first seven nights. This rate of decline can be thus considered to be a typical value for EY Cyg.

Figure 2 shows the nightly light curves (please note the vertical axis is shifted reflecting the mean brightness of the object) for the 1992 outburst. These light curves show slow modulation with a time-scale of ∼0.1–0.2 d. On the first night (April 5), a slow decline and a shallow minimum near the end of the run was observed. On April 7, a

Table 1. Nightly averaged magnitudes of EY Cyg

Start[a]	End[a]	Mean mag[b]	Error[c]	N^d	Site
48718.257	48718.337	1.481	0.002	192	Ouda
48720.209	48720.329	1.764	0.002	332	Ouda
48724.207	48724.327	2.967	0.002	258	Ouda
52229.061	52229.073	0.496	0.012	24	Kyoto
52230.049	52230.066	0.673	0.006	42	Kyoto
52233.020	52233.028	1.485	0.005	22	Kyoto
52234.062	52234.082	1.856	0.009	49	Kyoto
52235.032	52235.053	2.170	0.006	50	Kyoto
52236.019	52236.044	2.439	0.013	61	Kyoto
52237.023	52237.044	2.506	0.031	43	Kyoto
52239.018	52239.041	2.674	0.055	46	Kyoto
52240.010	52240.020	3.064	0.054	21	Kyoto
52241.007	52241.021	2.934	0.024	35	Kyoto
52245.007	52245.020	2.908	0.058	27	Kyoto
52247.989	52248.007	2.969	0.028	42	Kyoto

[a] BJD−2400000.
[b] Relative magnitude (see text).
[c] Standard error of nightly average.
[d] Number of frames.

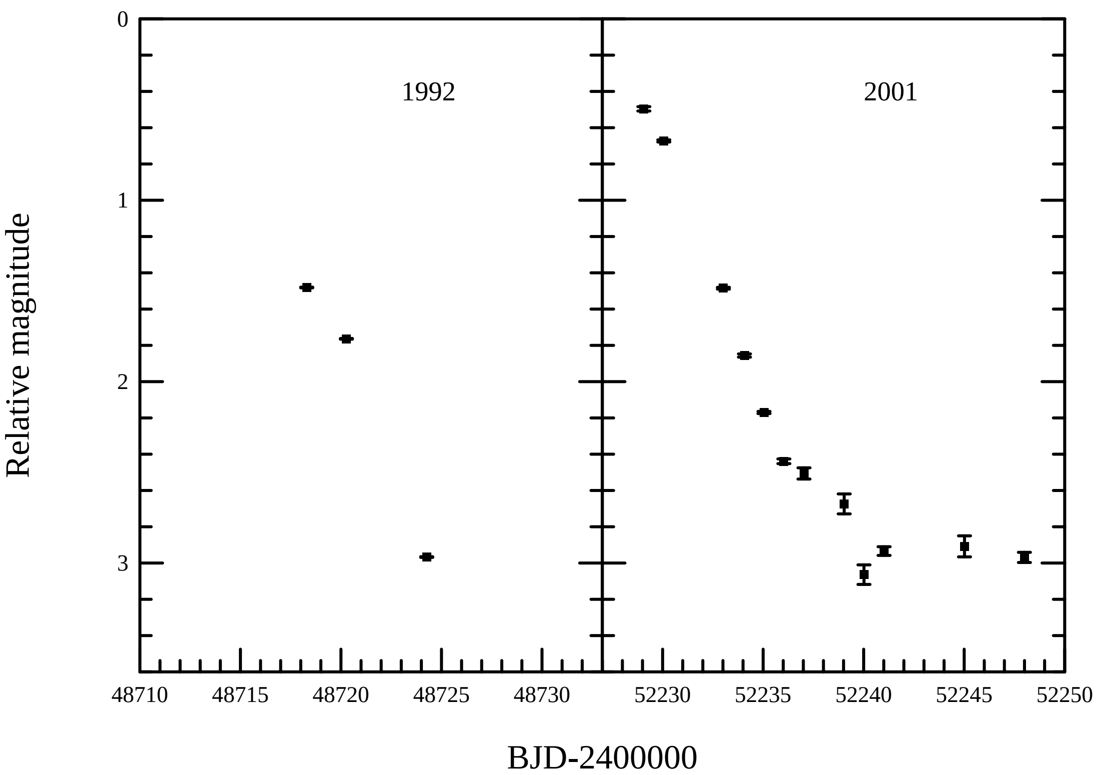

Figure 1. Light curve of EY Cyg on two outbursts in 1992 and 2001. The zero point for the 1992 observation corresponds to $V = 10^{\rm m}.39 \pm 0^{\rm m}.08$.

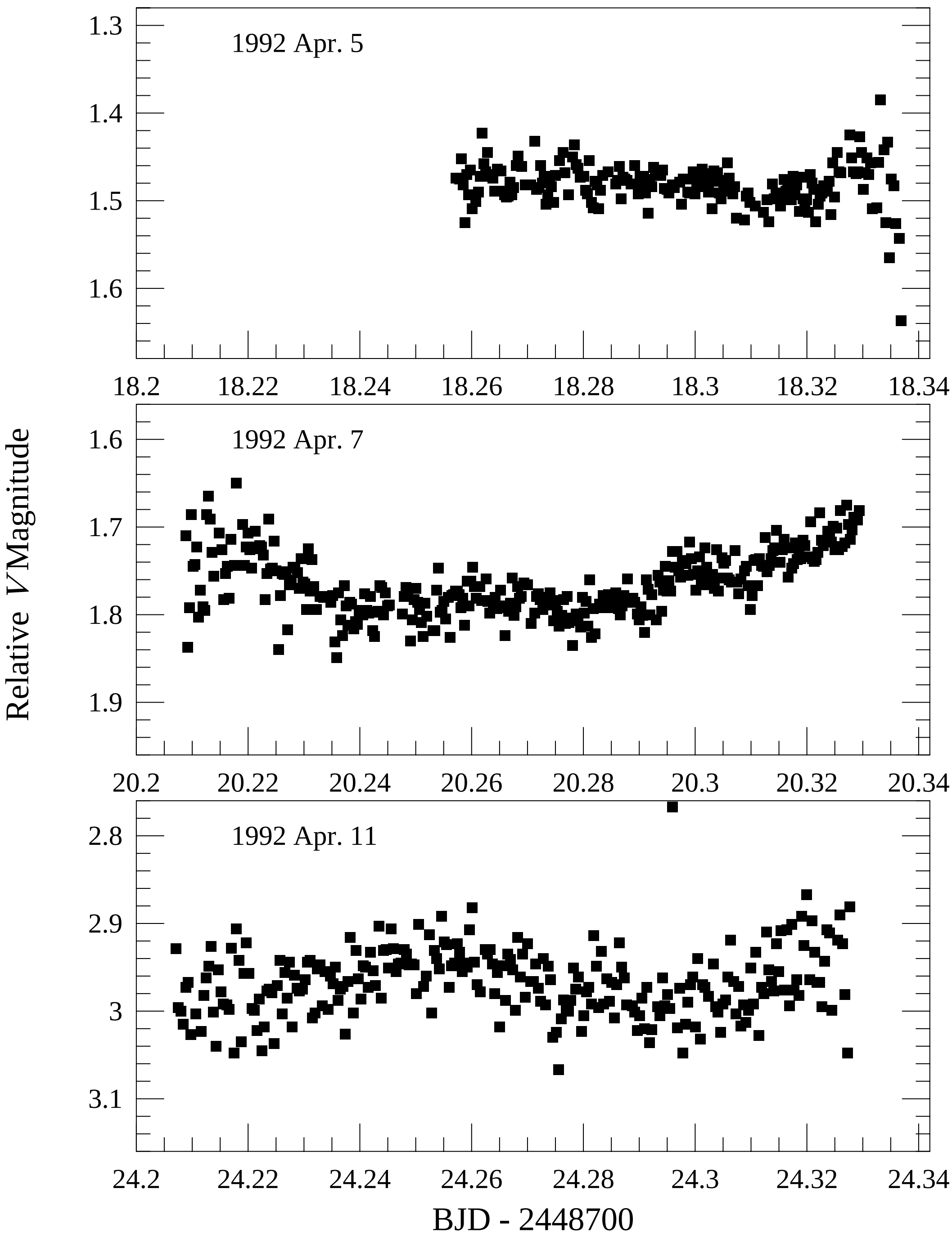

Figure 2. Light curve of the 1992 April outburst of EY Cyg. The zero points are the same as in Figure 1.

fading and brightening clearly defined a rather flat-bottomed minimum. On April 11, the variation looks more sinusoidal. This observation makes the unique time-resolved photometry during outburst. To our best knowledge, these modulations look to more reflect slow quasi-periodic variations rather than the stable orbital period. A period search between $0^{\mathrm{d}}.1$ and $0^{\mathrm{d}}.3$, using the Phase Dispersion Minimization (PDM) method (Stellingwerf 1978), has yielded the strongest signals near $0^{\mathrm{d}}.192$ and $0^{\mathrm{d}}.212$, but the values should be treated with caution because neither observing run was long enough to adequately assess the possibility of a longer periodicity. Because of the shortness of each run, we were not able to test the presence of this periodicity in the 2001 observation.

The orbital period of EY Cyg has not been yet unambiguously determined. Hacke and Andronov (1988) gave a photometric period of $0^{\mathrm{d}}.18228$ from their photographic observations. Sarna et al. (1995) further obtained CCD photometry and gave a period of $0^{\mathrm{d}}.2165$. Smith et al. (1997) obtained optical spectra and identified the secondary as a K5–M0 star. The lack of radial velocity variations observed by Smith et al. (1997) suggests a low inclination system. Since a K5–M0 companion usually suggests a longer orbital period (cf. Ritter and Kolb 1998), these photometric periodicities need to be further examined.

The decline rate observed in this study is 0.28–0.30 mag d^{-1}, which is close to that of DX And (Kato and Nogami 2001), a dwarf nova with an orbital period of $0^{\mathrm{d}}.4405$. From the similarity of outburst cycle lengths and outburst durations between EY Cyg and DX And, and from the application of Bailey's relation (Bailey 1975; Szkody and Mattei 1984; Warner 1995) to the decline rates, we propose a longer orbital period close to that of DX And.

Regarding short-period oscillations, we detected low-amplitude (<0.05 mag), fluctuations with time scales of 10–60 min (small wiggles in Figure 2), but we could not find any firm periodicity.

This work is partly supported by a grant-in aid (13640239) from the Japanese Ministry of Education, Culture, Sports, Science and Technology. Part of this work is supported by a Research Fellowship of the Japan Society for the Promotion of Science for Young Scientists (MU).

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