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A DEEP DIP DURING AN OUTBURST IN THE OLD NOVA, Q CYGNI

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Q Cyg is an old fast nova ($t_3 \sim 11$ d) which reached $V = 3^{\rm m}$ at the maximum of the 1876 outburst. In quiescence after the outburst ($V \sim 15^{\rm m}$) this object has been revealed to show large-amplitude modulations, which are called "stunted" outbursts by Honeycutt et al. (1998, and see references therein for earlier studies on this behavior). Honeycutt (2001) listed that the mean amplitude, the typical spacing, and the mean full-width-at-half-maximum (FWHM) of outbursts are $1\overset{\rm m}{.}0$, about 200 d, and 24 d, respectively. Although $\sim$ 10 old novae other than Q Cyg is now known to exhibit such "stunted" outbursts (Honeycutt 2001), the mechanism is still a mystery. To investigate the accretion disk in outburst, we carried out time-resolved photometry during an outburst in 1994, detected by T. Vanmunster (private communication).

We made the observations at Ouda Station, Kyoto University. A 60-cm reflector (focal length = 4.8 m) and a CCD camera (Thomson TH 7882, 576 × 384 pixels with on-chip 2 × 2 binning) attached to the Cassegrain focus were used (for more information of the instruments, see Ohtani et al. 1992). We adopted a Johnson V-band interference filter. Table 1 gives the journal of the observations. After standard de-biasing and flat fielding, the frames were processed by a microcomputer-based aperture photometry package developed by one of the authors (TK).

The magnitudes of the object were measured relative to a local standard star, Q Cyg–31 ($V = 13.375$, $B-V = +0.754$) in Henden and Honeycutt (1997). Heliocentric corrections to observed times were applied before the following analysis. Relative magnitudes between the comparison star and a local field star were measured to confirm the constancy of the comparison star within $0\overset{\rm m}{.}04$ during our runs and to calculate the errors listed in Table 1.

The long-term light curve derived from our observations of this outburst is drawn in Figure 1. This is of a typical decline shape of outburst in Q Cyg, while the decline rate of 0.07 mag d^{-1} is a little large for this star (cf. Honeycutt et al. 1998). In our observations, we could not detect any short-term periodic modulations, such as superhumps and quasi-period oscillations (QPOs), in a period range of 0.002–0.2 d.

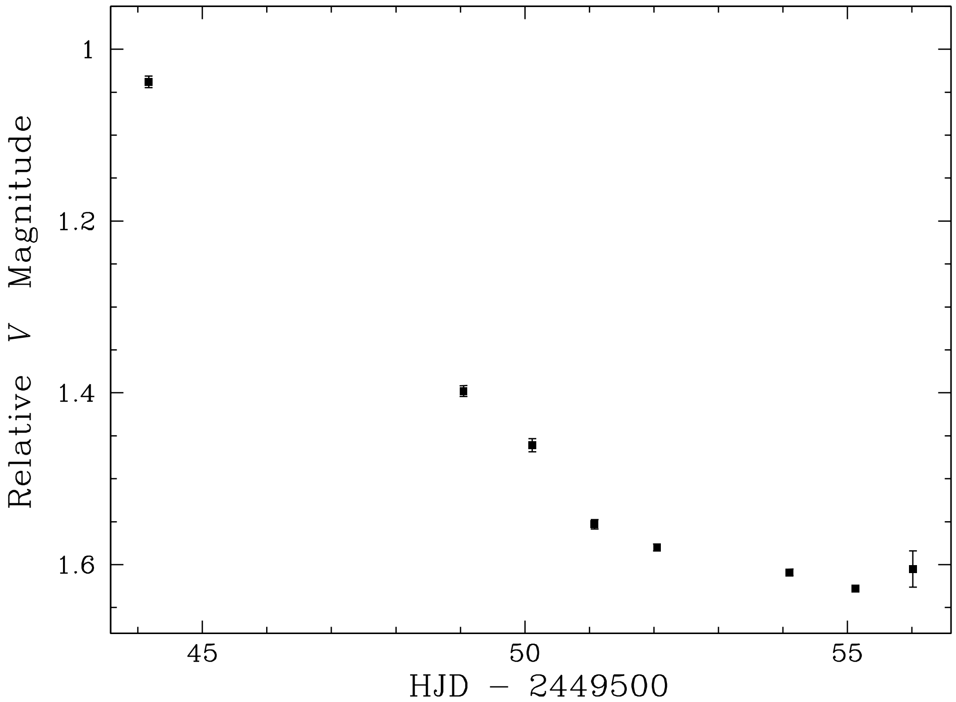

Figure 1. Light curve of Q Cyg between 1994 July 10 and 22

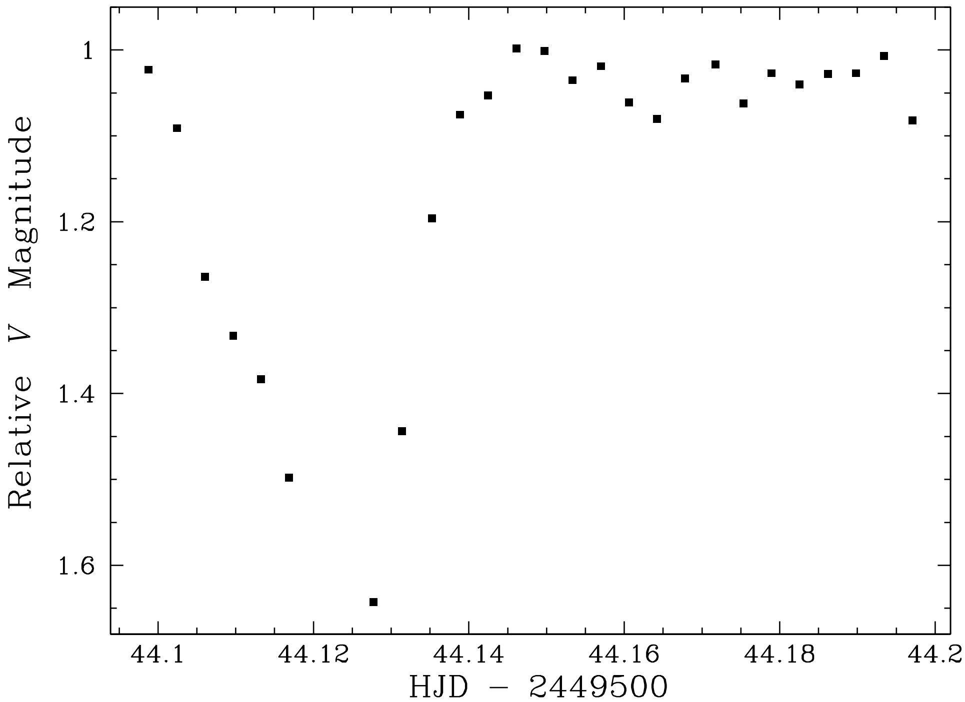

Figure 2. The deep dip observed on 1994 July 10

Table 1: The observation summary

Date	HJD start[1]	HJD end[1]	Exposure time (s)	Error[2]	Mean V mag[3]	N[4]
1994 July 10	49544.098	49544.200	300	0.03	1.038	17
15	49548.987	49549.106	100	0.03	1.398	87
16	49550.096	49550.132	180	0.03	1.461	16
17	49551.029	49551.131	90	0.05	1.553	82
18	49551.966	49552.130	90	0.05	1.580	134
20	49554.003	49554.255	90	0.05	1.609	149
21	49554.961	49555.269	90	0.05	1.628	230
22	49555.975	49556.059	100	0.14	1.605	47

[1] HJD − 2400000
[2] Nominal error for 1 point
[3] Magnitude relative to a local standard star ($V = 13.375$)
[4] Number of frames

The most remarkable feature in our data is a deep dip ($\triangle m \simeq 0.65$) with a duration of about 1 hour observed on 1997 July 10 (Figure 2). We examined the original images to reject the possibilities of effects of clouds and other natural/artificial factors and ensured the existence of the dip. Although two similar dips were detected in Q Cyg by Honeycutt et al. (1998), the dip in the present data seems to have a different nature than those dips because of two reasons: 1) the duration was quite different (1 hour versus several-tens of days), and 2) the dip in our data occurred in a bright phase, but those dips were observed in "quiescence", following two separate outbursts.

This may be an eclipse of the accretion disk by the secondary star. This interpretation is, however, not plausible, since the low inclination angle is implied by the fact that any orbital feature has never been detected in spite of the long observational history of this old nova. There is another possibility of an eclipse by the third body, although its orbit may be needed to be more inclined from the orbital surface of the primary and the secondary stars and the duration may be too short. The third possibility is a transient increase of absorption by mass sporadically ejected (cf. BZ Cam, Ringwald & Naylor 1998; AT Cnc, Nogami et al. 1999). To solve this difficult problem and to understand the nature of the oscillations in old novae, we would encourage extensive time-series photometry and spectroscopy to seek for orbital feature and an evidence of mass ejection.

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