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OBSERVATIONS OF SUPERHUMPS IN AQ Eri

Photographic and visual detection of superhumps of this star was done by Kato et al. (1989). They yielded a superhump period of 0.06703 days. However confirmatory observations are necessary because their period was mainly based on photographic data on one night.

The star had again a long outburst starting on February 17, 1991, at mv=13.0 (Koshiro, private communication). This outburst lasted for at least 10 days. However the maximum seems to be significantly fainter than the previous one (mv=12.5).

During this presumable superoutburst, we planned to confirm the superhump period.

The observations were done from February 23 through 26, 1991 with Thomson TH7882 CCD (576×384 pixels, on chip summation of 2×2 pixels) attached to the Cassegrain focus (focal length 4.8m) of 60cm reflector at Ouda Station, Kyoto University.

The Kron I filter (λmax=780nm, FWHM=156nm) was employed to get the best signal to noise ratio. The exposure time was mostly 10 seconds to detect short timescale variability, such as quasi-periodic oscillations (QPOs) and eclipses, but was 20 or 30 seconds when atmospheric condition was poor.

The frames were processed with the microcomputer-based aperture photometry package developed by the author. The variable (Var) and the comparison (Comp) are marked in Figure 1.

Because of the high sky background due to the nearly full moon located above the variable, the r.m.s. error of a single photometry was 0.05 magnitudes. No systematic variation larger than 0.01 magnitudes between comparison and neighboring stars were detected.

The overall light curve is shown in Figure 2 and those on individual night (February 24, 25, 26) are shown in Figures 3a-c. Each dot represents a differential magnitude between the variable and the comparison.

On February 23, there existed some indication of light variation suggesting superhumps. However the times of maxima cannot be determined because of the cloudy sky. On February 24, superhumps with an amplitude of 0.19 magnitudes were evident. The rise was much steeper than the decline. On February 25, the superhumps became less marked. The amplitude was 0.08 magnitudes and the rise became slower than in the previous night. The light curve on February 26 was similar to that on February 25, but the amplitude increased to 0.14 magnitudes.

Table 1 summarizes the times of superhump maxima on the last three nights.

The intervals between successive superhumps ranged from 0.056 to 0.062 days. By fitting linear equation to the observed time of maxima, the superhump period was determined as either 0.06225 days or 0.05854 days. The latter gives the smaller O-C residuals, but another coexistent periodicity described later is better explained by the longer period.

The 0.06225-day period is 7% shorter than that suggested by Kato et al. (1989). There seems to have been the passing-over of one or two cycle counts per day in their data. Reanalysis of their times of maxima using the present period gives the more probable periods of 0.06284 or 0.05914 days.

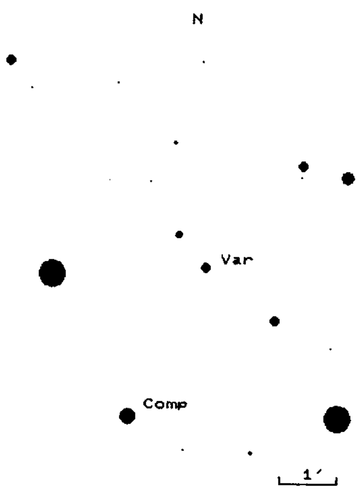

Figure 1.

Table 1.

Time of maxima Feb.1991 (UT)	$O-C_1$ days	$O-C_2$ days
24.442	-0.001	+0.002
24.500	-0.002	-0.002
24.562	+0.002	-0.003
25.439	0.000	+0.003
25.500	+0.003	+0.002
26.434	0.000	+0.002
26.490	-0.002	-0.004

$O-C_1$: $Max.UT = 24.443 + 0.05854E$

$O-C_2$: $Max.UT = 24.440 + 0.06225E$

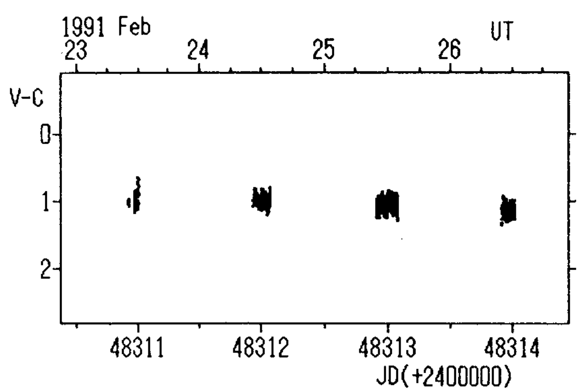

Figure 2.

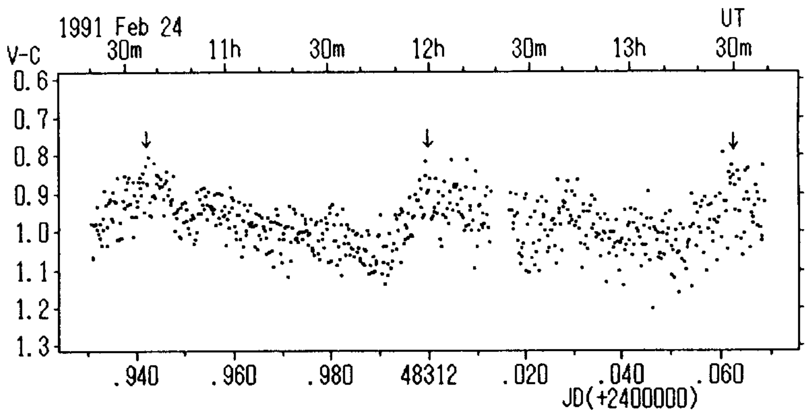

Figure 3a.

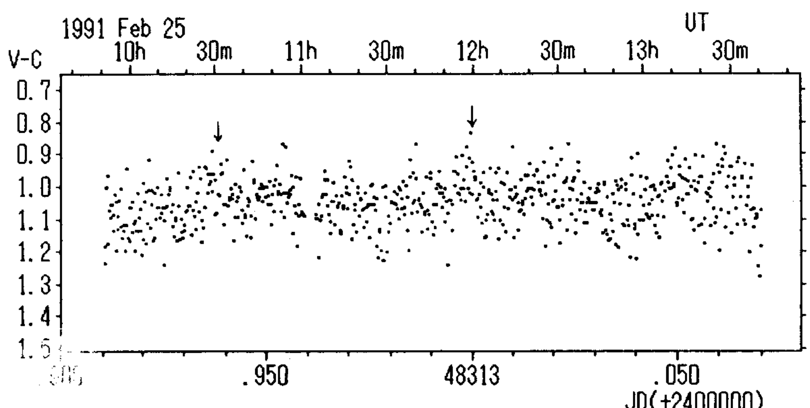

Figure 3b.

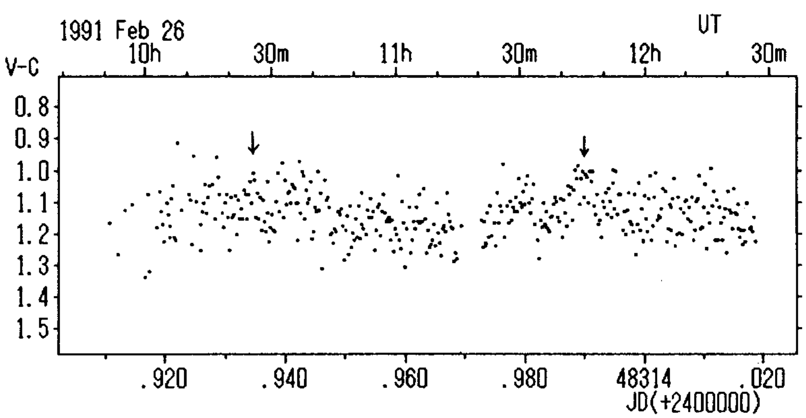

Figure 3c.

If the shorter period is adopted, AQ Eri will be similar to SW UMa (superhump period Psh=0.05833 days, orbital period Porb=0.056815 days). The similarity of both systems is also supported by statistical analysis of outburst records (Iida, in preparation). In either cases of the period, AQ Eri will have the fourth shortest orbital period confirmed among the SU UMa stars.

The amplitude of the superhumps varied in one day. If this is interpreted as a beat phenomenon between Psh and Porb, as observed in high inclination systems, the beat period will be 2 or 3 days. This value is typical for SU UMa stars except for WZ Sge (Osaki 1985).

The superhump profile has recently been employed as a potential clue to distinguishing mechanisms for superhumps (Mineshige 1988). There was some indication of a secondary bump at superhump phase 0.4 following the second superhump on February 24. This feature, however, was not persistent, while it was stable in SU UMa (Udalski 1990).

At 24.950 UT, a 0.06 magnitude dip lasting 7 minutes was observed. The fade and the rise took less than a minute. This dip may be caused by a transient eclipse as observed in TY PsA at the late stage of the superoutburst (Warner et al. 1989).

Fourier analysis of the original data revealed an additional stable periodicity of 22.9 minutes on February 25 and 26. Similar periodicity during an outburst of WX Hyi was interpreted as a result of 4:1 or 6:1 resonance in the accretion disk with the binary orbit (Kuulkers et al. 1991). In the present case the period is very close to 1/4 superhump period (if Psh=0.06225 is adopted), which is certainly longer than the orbital period. The difference is naturally expiained if the 22.9 minute period results from the non-axisymmetric structure of the disk which is precessing at the same angular velocity with the one-armed (eccentric) disk causing superhumps. Further observations during quiescence are required to rule out the possibility of the 22.9 minute period as the rotational period of the white dwarf.

From this discussion mentioned above, we suggest the superhump period of 0.06225 days is more realistic than that of 0.05854 days.

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