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CONFIRMATION OF THE SU UMa NATURE OF V1504 Cyg

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Variability of V1504 Cyg was discovered by Beljawski (1936), and designated as S4693. Then, Crocker (1978) measured the outburst duration of 3–14 days and Kurochkin (1981) suggested that the variable star belongs to Z Cam-type dwarf novae with the outburst recurrence cycle of 5.823 days. Richter (1987) suspected that V1504 Cyg is an SU UMa-type dwarf nova with a recurrence time irregularly varying between 6.5 and 15 days. Raykov and Yushchenko (1988) suggested that V1504 Cyg is an SU UMa star having the recurrence cycle of the normal outburst of 9–10 days, at shortest 6 days, and that of the long outburst (lasting $\sim$ 10 days) of about 100 days. All these studies are based on photographic surveys. A spectrum obtained by Munari et al. (1997) shows the typical characteristics of dwarf novae in outburst.

We made photometric observations in 1994 October 31.402–31.531(UT) and in November 3.441–3.523(UT) during a long outburst, using 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 (for details of the instrumentation, see 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. We used an interference filter which had been designed to reproduce the Johnson V band. The exposure time was 90 s. The dead time between exposures was typically 13 s.

After standard corrections of de-biasing and flat-fielding, the frames were processed by an aperture photometry package developed by Taichi Kato, Kyoto University. The magnitudes of the variable were determined using a local standard star marked as Comp in Figure 1. The comparison of the standard star with three check stars C_1, C_2, and C_3 in Figure 1 has indicated the constancy of the standard within 0.02 mag during our observations. It also gives 0.02 mag as the nominal 1-sigma error for a single frame in the differential magnitudes for the variable. The V magnitudes of the comparison star and the check stars (C_1–C_3) are given as 12.28, 13.71, 11.87, and 12.15 in the VSNET chart (available at the URL: ftp://ftp.kusastro.kyoto-u.ac.jp/pub/vsnet/charts/V1504_Cyg.ps) respectively.

The light curves are shown in Figure 2. Superhumps with an amplitude of about $0^{\rm m}.2$ are clearly seen on 1994 Oct. 31, though the shape is distorted probably due to the secondary superhump on Nov. 3. We, thus, identify V1504 Cyg as being an SU UMa-type dwarf nova.

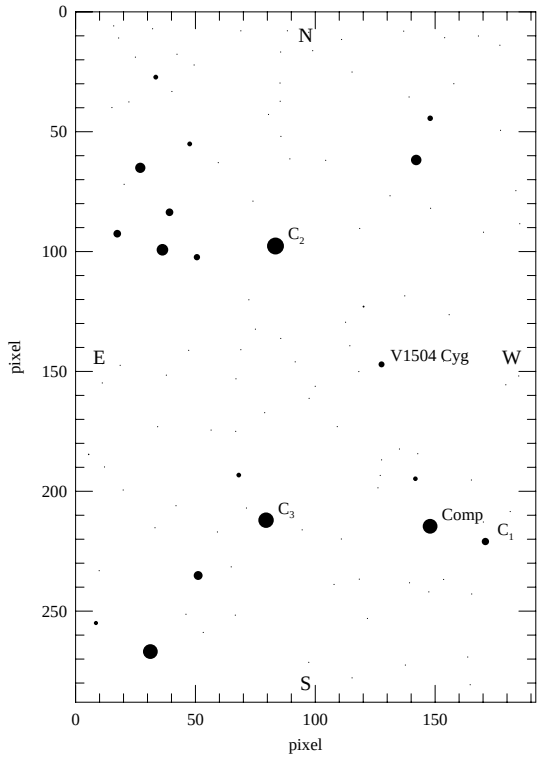

Figure 1. Finding chart of V1504 Cyg. The star marked as Comp is a local standard star whose V magnitude is 12.28 in the VSNET chart. C_1, C_2, and C_3 are check stars.

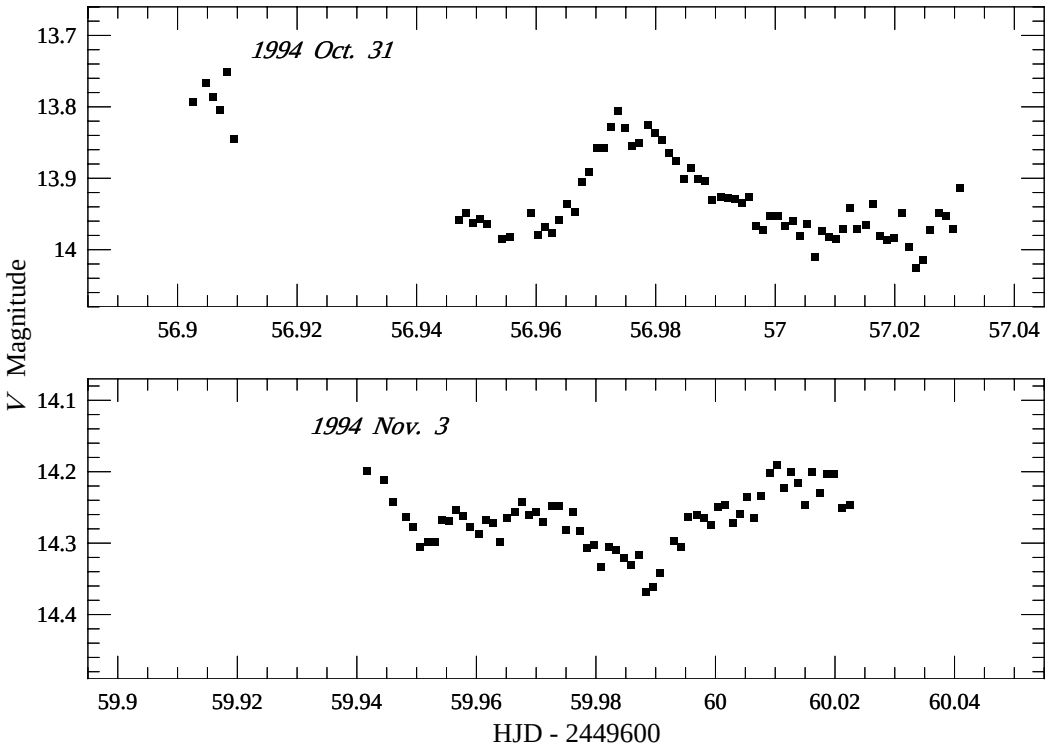

Figure 2. Superhumps observed on 1994 Oct. 31 and November 3.

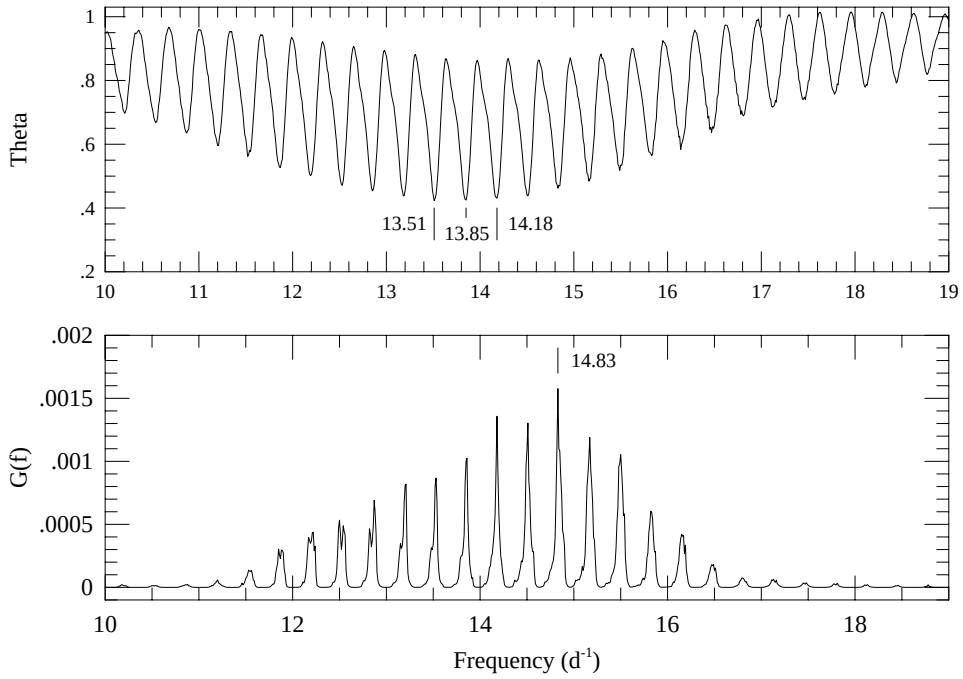

Figure 3. Results of period analyses using PDM technique (upper panel) and LANCELOT (lower panel) on the data shown in Figure 2. The inconsistency of the results may be caused by short coverages and change of the superhump shape.

The mean decline rate during the observations is $\sim$0.11 mag d^{-1}. After subtracting the linear decline trend from all our data, we performed period analyses using the Phase Dispersion Minimization (PDM) method (Stellingwerf 1978) and LANCELOT (period analysis using artificial neural networks, Gaspani 1997, available at the URL: ftp://ftp.kusastro.kyoto-u.ac.jp/pub/vsnet/others/LANC/). The resultant theta diagram (PDM) and G(f) function (LANCELOT) are shown in Figure 3. The minimum and maximum points respectively correspond to the best estimates of the period. The results are inconclusive probably due to short coverages spanning 3 days and change of the superhump shape. The superhump period of V1504 Cyg is implied to be around $0^{\rm d}.07$, but this value has to be improved.

Based on the VSNET posts, Kato (1997) reported that the shortest interval between superoutbursts and normal outbursts are 116 d and 11 d, respectively, which are consistent with the values cited earlier in this paper (see Table 1). Those recurrence cycles are very short for the SU UMa star (see Table 1 in Nogami et al. 1997). In order to study the evolution of dwarf novae it is quite important to measure the orbital period precisely and reveal the recurrence pattern of outbursts in V1504 Cyg.

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Table 1: Recent behavior of V1504 Cyg. This table is according to Kato (1997).

Date (JD)	mag	outburst type	Note
2449514	13.4	super	
2449611	14.9	?	single obs.
2449630	14.3	?	single obs.
2449653	14.0	?	single obs.
2449660–662	14.4	?	
2449864	14.5	?	single obs.
2449895	15.6	?	single obs.
2449904–908	13.9	super	
2449930	15.9	?	single obs.
2449954	14.7	normal	
2449975	14.5	normal	
2450007	14.6	normal	
2450020–027	13.9	super	
2450110	14.3	?	single obs.
2450219	14.6	?	single obs.
2450229	14.9	?	related to 50219?
2450248	14.7	normal	
2450270	15.2	normal	single obs.
2450289	14.6	normal	
2450312	15.3	normal	
2450316	14.6?	?	single obs.
2450339–341	14.8	normal	
2450361	14.8	normal	
2450372	15.2	normal	
2450400–406	14.2	super	
2450419	14.9:	normal?	single obs.

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