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NEW SU UMa-TYPE DWARF NOVA DM Dra

KATO, TAICHI[1]; UEMURA, MAKOTO[1]; ISHIOKA, RYOKO[1]; MATSUMOTO, KATSURA[2,1]; TANABE, KENJI[3]

[1] Dept. of Astronomy, Kyoto University, Kyoto 606-8502, Japan,
e-mail: (tkato,uemura,ishioka)@kusastro.kyoto-u.ac.jp

[2] Graduate School of Natural Science and Technology, Okayama University, Okayama 700-8530, Japan,
e-mail: katsura@cc.okayama-u.ac.jp

[3] Department of Biosphere-Geosphere Systems, Faculty of Informatics, Okayama University of Science, Ridai-cho 1-1, Okayama 700-0005, Japan, e-mail: tanabe@big.ous.ac.jp

DM Dra (=SVS 2426) was originally discovered by Stepanian (1982), who detected an outburst at 15.5 m_{pg} on JD 2443965. The object was reported to be $\sim$19.5 m_{pg} in quiescence. Stepanian (1982) also obtained a low-resolution spectrum during this outburst, and reported that the spectrum resembled an $O-B$ star. The object was also included in the Second Byurakan Sky Survey as a blue stellar object SBS 1533+599 (Balayan 1997). The object was also detected by the ROSAT X-ray satellite (Verbunt et al. 1997).

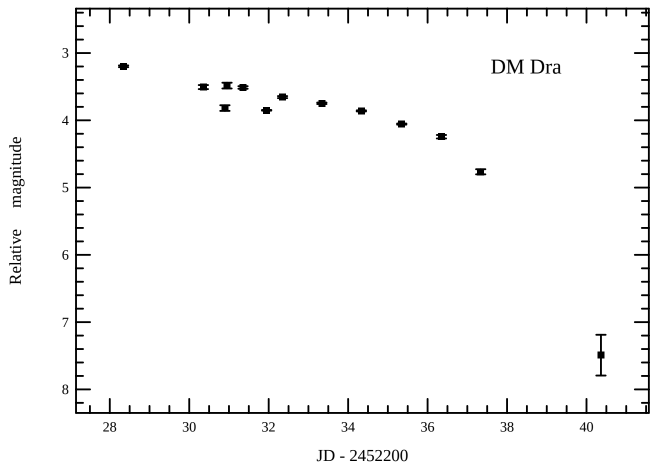

Figure 1. Overall light curve of the 2001 November outburst of DM Dra.

During the survey of faint cataclysmic variables (CVs) at high galactic latitudes (Howell, Szkody 1990), Howell et al. (1990) reported a short CCD time-series photometry of DM Dra in quiescence. Howell et al. (1990) suggested the possible existence of a period of $\sim$125 min, and a possible fading by 0.4 mag for a duration of 5 min. From this observation, DM Dra has been considered as a candidate SU UMa-type dwarf nova

Table 1. Log of observations

JD start[a]	JD end[a]	mean mag[b]	error[c]	N[d]	exp[e]	Inst.[f]
51844.916	51845.008	4.195	0.021	192	30	1
52228.327	52228.367	3.197	0.013	96	30	2
52230.343	52230.369	3.506	0.030	39	30	2
52230.896	52230.900	3.818	0.042	10	30	3
52230.901	52231.001	3.484	0.043	138	45	3
52231.338	52231.370	3.512	0.019	58	30	2
52231.898	52231.997	3.851	0.005	220	30	3
52232.329	52232.369	3.655	0.015	82	30	2
52233.309	52233.366	3.747	0.011	136	30	2
52234.305	52234.361	3.860	0.008	103	30	2
52235.325	52235.372	4.056	0.008	111	30	2
52236.326	52236.373	4.244	0.026	110	30	2
52237.305	52237.368	4.765	0.038	151	30	2
52240.355	52240.372	7.491	0.303	41	30	2

[a] JD−2400000.
[b] Relative magnitude to GSC 3875.203.
[c] Standard error of nightly average.
[d] Number of frames.
[e] Exposure time (s).
[f] 1: Kyoto (25cm + ST-7), 2: Kyoto (30cm + ST-7E), 3: OUS (30cm + ST-9E)

(see Warner (1995) and Osaki (1996) for recent review of SU UMa-type dwarf novae). The star has therefore been monitored since 1995 by the members of the VSNET Collaboration (`http://www.kusastro.kyoto-u.ac.jp/vsnet/`). Two secure long outbursts (initial positive detections on JD 2451818 and 2452227) and a possible outburst on JD 2451082 have been reported. We conducted CCD time-series observations during the two recent long outbursts.

The observations were mainly done using an unfiltered ST-7E camera attached to the Meade 30-cm Schmidt-Cassegrain telescope at Kyoto University. Some Kyoto observations were made using an unfiltered ST-7 camera attached to the Meade 25-cm Schmidt-Cassegrain telescope. The observations at Okayama University of Science (OUS) were done using an unfiltered ST-9E camera attached to a 30-cm Cassegrain telescope. All systems give magnitudes close to R_c. The exposure times were mostly 30 s; the OUS observations on JD 2452230 mostly used 45 s exposure times. The images were dark-subtracted, flat-fielded, and analysed using the Java^{TM}-based PSF photometry package developed by on of the authors (TK). The differential magnitudes of the variable were measured against GSC 3875.203 (Tycho-2 V-magnitude 11.24, $B-V$=0.44), whose constancy during the run was confirmed by comparison with GSC 3875.555 (Tycho-2 V-magnitude 10.75, $B-V$=0.36). The log of observations is summarised in table 1. Barycentric corrections were applied before the period analysis.

Figure 1 shows the overall light curve of the best observed outburst (2001 November). The initial observation started within 1 d of the outburst detection by Timo Kinnunen. The outburst lasted at least 10 d. The overall light curve resembles the plateau portion of an SU UMa-type superoutburst (cf. Warner 1985). The mean rate of decline between JD

2451844 and 2452236 was 0.12 mag d^{-1}, which is a quite typical value for an SU UMa-type superoutburst. The object then experienced a sudden drop by 2.7±0.3 mag in 3.0 d.

Figure 2 shows a representative enlarged light curve of DM Dra during the plateau stage of the outburst. The light curve clearly shows the presence of superhumps with amplitudes of 0.2–0.3 mag. The observation established the SU UMa-type nature of DM Dra, which is consistent with the above findings of the general behavior of the outburst.

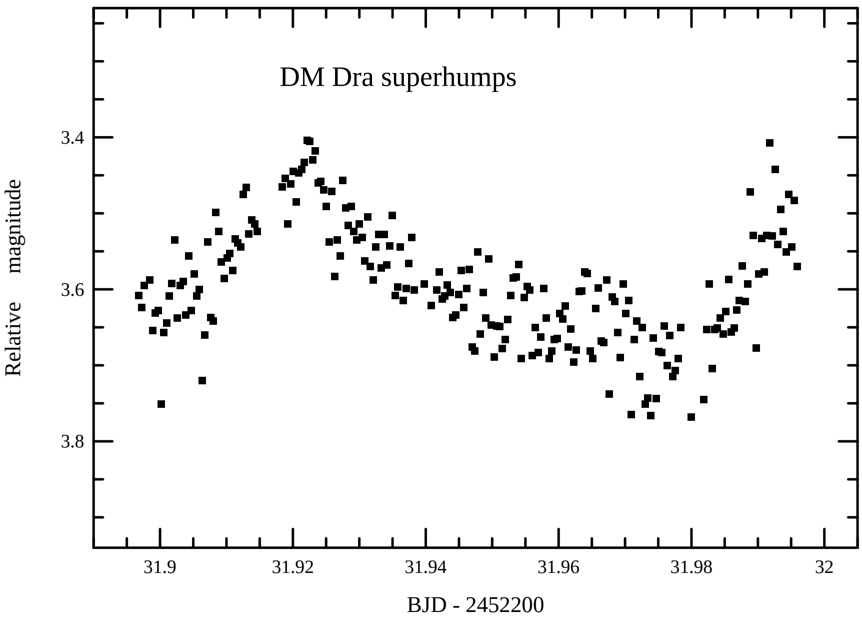

Figure 2. Enlarged light curve of the 2001 November outburst of DM Dra.

In order to more precisely determine the superhump period, we performed period analysis using Phase Dispersion Minimization (Stellingwerf 1978), after removing the systematic trend of decline and a small systematic difference between Kyoto and OUS observations. The θ-diagram and the phase averaged profile of superhumps is shown in Figure 3. The best-determined superhump period is 0.07561±0.00003 d, which is consistent with the period (0.0734±0.0030 d) based on single-night independent superhump observation by T. Vanmunster, (vsnet-alert 6886). The superhump period is far shorter than the possible 125 min periodicity (Howell et al. 1990) in quiescence, making the 125 min unlikely for the orbital period. No eclipse-like fading was observed (Figure 2). The slight difference between superhump profiles between Figure 2 and 3 suggests the presence of time-evolution of superhumps, which is commonly seen in SU UMa-type dwarf novae (e.g. Baba et al. 2000). The evolution was not, however, followed in detail owing to the unavoidable shortness of nightly runs.

The long duration of the 2000 October outburst (at least 11 d; possibly preceded by a precursor brightening) as inferred from the VSNET observation qualifies the superoutburst nature of this outburst.[1] The interval between these two superoutbursts (supercycle) is 393 d, which is a relatively long one among known SU UMa-type dwarf novae (see compilations in Warner 1995 and Nogami et al. 1997).

[1]Although the 2000 Oct. 27 observation covered 0.091 d, the upper limit of superhump-type variation was 0.1 mag. This suggests that superhumps had already decayed (cf. Baba et al. 2000 for a similar example) at the time of the observation.

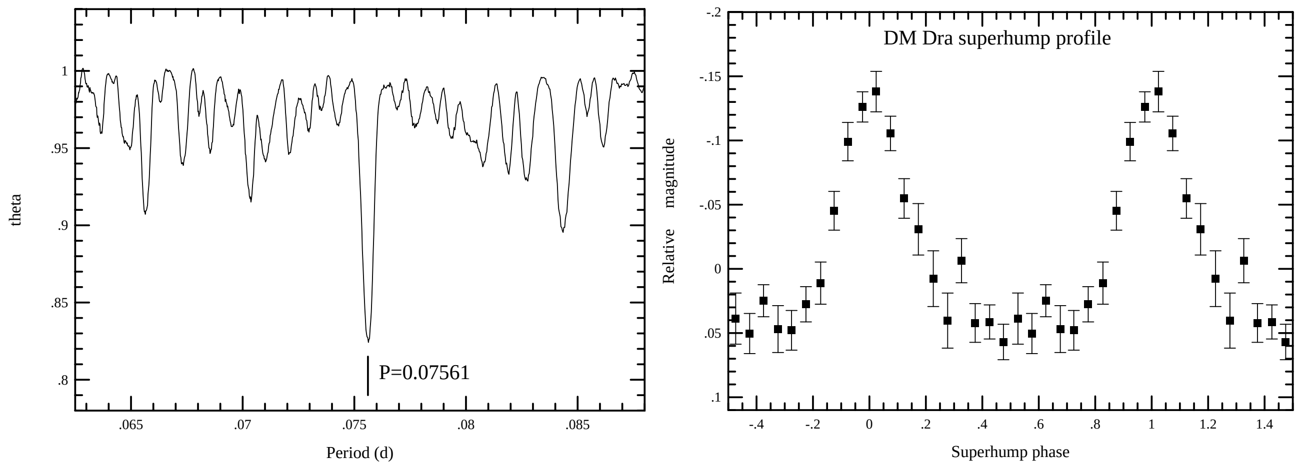

Figure 3. θ-diagram and the phase averaged profile of superhumps.

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