COMMISSIONS 27 AND 42 OF THE IAU
INFORMATION BULLETIN ON VARIABLE STARS
Number 4760

Konkoly Observatory
Budapest
30 August 1999
HU ISSN 0374 – 0676

CCD PHOTOMETRY OF THE 1999 OUTBURST OF CG CMa

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CG CMa was discovered by Verlooy on Franklin-Adams plates taken in 1934. According to Duerbeck (1987), the maximum was reached on 1934 January 12. The object had been considered as a possible classical nova, one of most distant in our Galaxy. However, Duerbeck (1987) identified the possible quiescent counterpart, and discussed the possibility of a dwarf nova, based on the outburst amplitude. The cataclysmic classification, however, became less likely when Zwitter and Munari (1995) took the spectrum of the suggested quiescent counterpart, yielding shallow absorption lines resembling those of an isolated white dwarf.

The major breakthrough in understanding the nature of this object was brought by visual monitoring by R. Stubbings. His second historical outburst detection on 1999 February 22 (Stubbings 1999) provided a unique opportunity in unveiling the enigmatic object. The reported magnitude was $m_{\rm v} = 13.7$ on February 22.494 UT. On February 21, the object was invisible below mag 15.0.

The CCD observations were done using an unfiltered ST-7 camera attached to the Meade 25-cm Schmidt-Cassegrain telescope. The exposure time was 30 s. The images were dark-subtracted, flat-fielded, and analyzed using the Java$^{\rm TM}$-based PSF photometry package developed by one of the authors (TK).

Soon after the initial observation, we realized the outbursting object is slightly offset from the suggested quiescent counterpart. Using eight GSC 1.1 stars (mean residual $0\farcs3$), we obtained the coordinates of $07^{\rm h}04^{\rm m}05\fs28$, $-23^\circ45'34\farcs2$ (J2000.0). Using the 1997 December 27 image taken at Ouda Station, we yielded the coordinates of the proposed quiescent counterparts as $07^{\rm h}04^{\rm m}05\fs01$, $-23^\circ45'34\farcs8$ (J2000.0) on the same reference frame. The latter coordinates being within $1''$ of the USNO A1.0 position, it is now evident the outbursting object is different from Duerbeck's (1987) candidate. The finding was confirmed by Henden (1999) and Duerbeck et al. (1999), who actually resolved the two components. We, in the following analysis, consistently used the newly obtained coordinates of the outbursting object for locating the aperture and PSF, but because of the small separation of two components being always smaller than the seeing size, the obtained fluxes should be considered as the combined light. At the brightest epoch of CG CMa, the contribution of the fainter companion was estimated as 8 %. The flux of the variable was measured relative to GSC 6523.3618 ($V = 11.65$, $B - V = 1.07$, Sumner

Table 1: Nightly averaged magnitudes of CG CMa

JD start[a]	JD end[a]	mean mag[b]	error[c]	N^d
51232.074	51232.146	2.964	0.014	141
51232.897	51232.970	3.222	0.019	74
51234.904	51235.160	3.574	0.010	622
51236.935	51237.113	3.735	0.026	174
51237.907	51238.124	3.872	0.015	486
51238.912	51239.120	4.107	0.030	489
51240.911	51241.124	4.221	0.028	506
51242.080	51242.083	4.670	2.380	2
51242.920	51243.061	4.139	0.119	159
51243.910	51244.131	4.375	0.044	415
51247.915	51247.919	5.186	0.732	10
51248.917	51248.920	4.275	0.241	10
51249.913	51249.917	4.088	0.238	9
51253.917	51253.920	4.660	0.187	10
51255.084	51255.091	5.044	0.816	18
51260.926	51260.929	5.633	0.678	10

[a] JD − 2400000
[b] Magnitude relative to GSC 6523.3618
[c] Standard error of nightly average
[d] Number of frames

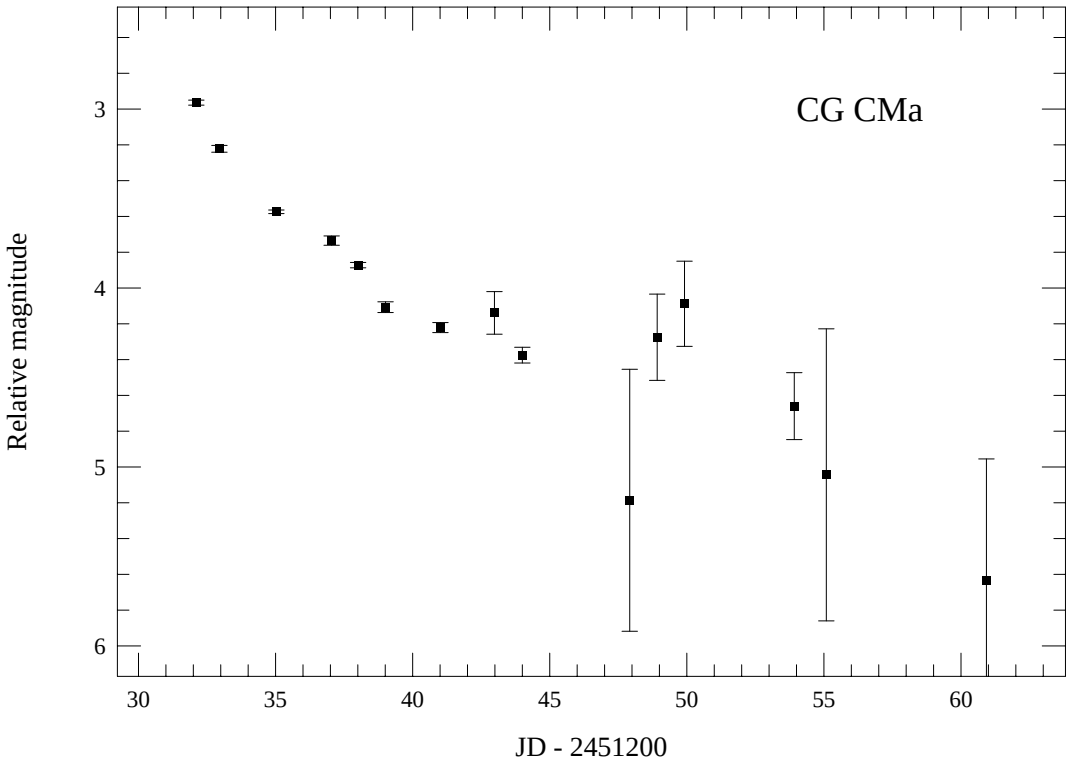

Figure 1. Overall light curve of CG CMa

and Henden 1999), whose constancy was confirmed by comparison with GSC 6523.1912. Table 1 summarizes the observations.

Figure 1 illustrates the overall light curve of the 1999 outburst of CG CMa. We consider the JD 2451260.9 point as the representative brightness of the companion (= quiescent brightness). The star initially declined at a rate of 0.17 mag d^{-1} for seven days, then the decline became slower. Even after 22 days after the outburst maximum, the object remained significantly brighter than quiescence. The outburst thus lasted more than 22 days. The overall light curve strongly resembles those of WZ Sge-type dwarf novae (eg. AL Com, Nogami et al. 1997). A possible fading, although the error was large due to the weather, at JD 2451247.9 (16 day past maximum) may correspond to a "dip" observed in AL Com (Nogami et al. 1997).

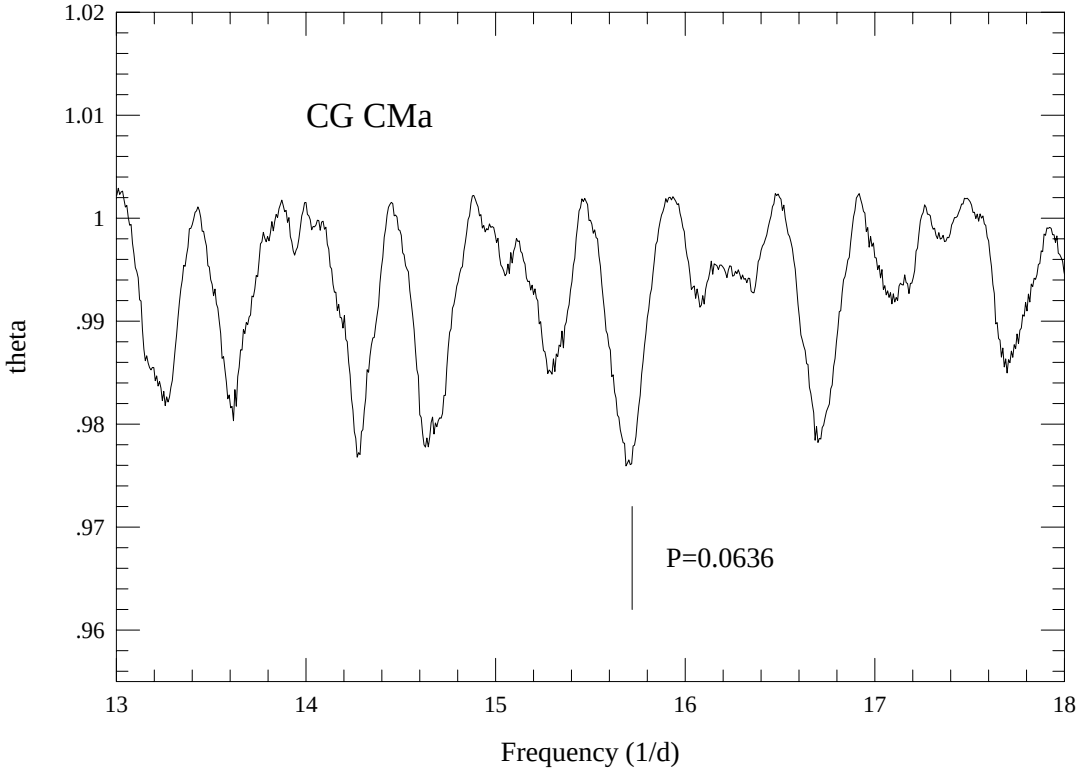

Figure 2. Period analysis of CG CMa

We searched for superhump modulations in the time-series data. There was no marked oscillation for the first two nights, but the wave emerged on February 25 (JD 2451235). The Phase Dispersion Minimization (PDM, Stellingwerf 1978) analysis was applied for the February 25–28 data, after removing the steadily declining trend. The resultant theta diagram is shown in Figure 2. The best period was 0.0636 $\pm$ 0.0001 d.

The superhump profile folded by this period is shown in Figure 3. The profile is that of typical, well-developed superhump. The full amplitude is 0.15 mag.

From the typical appearance of superhumps, we conclude CG CMa is a short period SU UMa-type dwarf nova, rather than a classical nova. The long duration and the profile of the outburst particularly suggest a WZ Sge-type classification, which rarely show outbursts. The inferred large outburst amplitude, which is a characteristic of WZ Sge-type dwarf novae, does not contradict with the astrometric implications (Henden 1999).

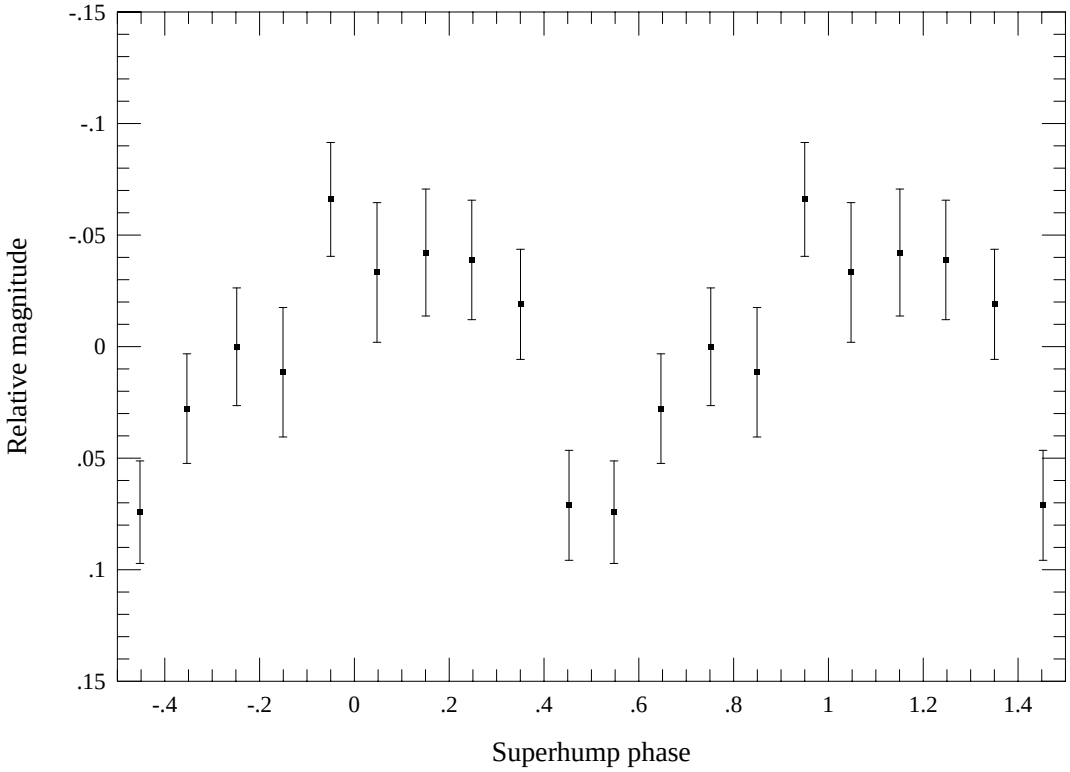

Figure 3. Superhump profile of CG CMa

This work is partly supported by the Grant-in-Aid for Scientific Research (10740095) of the Japanese Ministry of Education, Science, Culture, and Sports (TK). Part of this work is supported by a Research Fellowship of the Japan Society for the Promotion of Science for Young Scientists (KM).

References:

Duerbeck, H. W., 1987, *Space Sci. Rev.*, **45**, 58
Duerbeck, H. W., Schmeer, P., Knapen, J. H., Pollacco, D., 1999, *IBVS*, No. 4759
Henden, A., 1999, *VSNET chat circulation*, No. 1694 (also available from http://www.kusastro.kyoto-u.ac.jp/vsnet/Mail/vsnet-chat/msg01694.html).
Nogami, D., Kato, T., Baba, H., Matsumoto, K., Arimoto, J., Tanabe, K., Ishikawa, K., 1997, *ApJ.*, **490**, 840
Stubbings, R., 1999, *VSNET alert circulation*, No. 2666 (also available from http://www.kusastro.kyoto-u.ac.jp/vsnet/Mail/vsnet-alert/msg02666.html).
Stellingwerf, R. F., 1978, *ApJ*, **224**, 953
Sumner, B., Henden, A., 1999, *VSNET chat circulation*, No. 1650 (also available from http://www.kusastro.kyoto-u.ac.jp/vsnet/Mail/vsnet-chat/msg01650.html).
Zwitter, T., Munari, U., 1995, *Astron. Astrophys. Suppl.*, **114**, 575