COMMISSION 27 OF THE I. A. U.
INFORMATION BULLETIN ON VARIABLE STARS
Number 3529

Konkoly Observatory
Budapest
24 October 1990

HU ISSN 0374 - 0676

PHOTOMETRIC PERIODICITY OF V404 Cyg(=GS2023+338)

V404 Cyg is the optical counterpart of the X-ray transient source GS2023+338, a black hole candidate. Howell and Shafter (1990) recently determined the spectroscopic orbital period as 0.207 ± 0.015 days. However relatively large uncertainty remained because their observations did not cover the full orbital cycle. We here present an independent detection of photometric periodicity by the CCD photometry.

Our observations were done with Thomson CCD (576×384 pixels, on chip summation of 2×2 pixels) attached to the Cassegrain focus of the 60cm reflector at the Ouda Station on August 6 and 7, 1990. The Kron I filter (λeff=780nm, FWHM=156nm) was employed and the exposure time was 60 seconds in most cases, but was 120 seconds during the partial lunar eclipse on August 6.

The frames were processed with the point spread function photometry package developed by the author (TK). The processed image was shown in Figure 2. The magnitudes of the variable (V) and the check star (ch) were determined relative to the comparison star (C), which were then time-averaged to 0.01 day bins.

The results are shown in Table 1 and Figure 1. Table 1 includes the date of observation, the differential magnitude, Δm, the standard deviation, SD, and the number of frames averaged, n. The light curve on August 6 displays almost sinusoidal variation with an amplitude of 0.22 magnitude (figure 1). We could not detect neither flaring variation, which was seen during the outbursting phase (Wagner et al. 1989), nor evident eclipses. The least-squares fit to the sine function yields a period of 0.240 days, with an uncertainty of 0.008 days. During a short observation run on August 7, the variable was roughly constant at about 0.1 mag. brighter than the minimum magnitude in the previous night. This observation was not used to improve the period because of shortness of the run and the possible existence of night-to-night variation of the mean brightness.

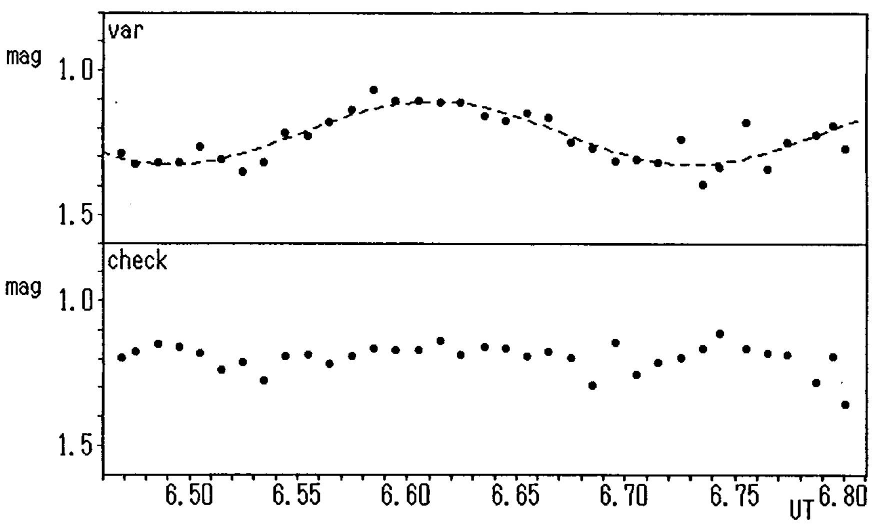
This periodic modulation of brightness may be interpreted as (a) ellipsoidal variation of the distorted secondary as in V616 Mon (McClintock and Remillard, 1986), (b) reflection effect of the heated secondary, and (c) changing aspect of the accretion disk or the hot spot, including partial obscuration of the accretion disk by the extended disk structure. The interpretation (a) will be rejected if the spectroscopic period actually represents the orbital period. In this case the photometric period must be the half of the orbital one. The cases (b) and (c) are more likely in this respect. The orbital inclination of the system was suggested to be low on account of the narrowness of the emission lines (Wagner and Starrfield, 1989). The small K_2-velocity of $74 \pm 9km/s$ (Howell and Shafter, 1990) also seems to support it. However, rapid X-ray variability caused by variable obscuration (Makino and the Ginga Team, 1989) implies a high inclination (Charles et al., 1990). Our photometric amplitude may offer an additional information on the orbital inclination.

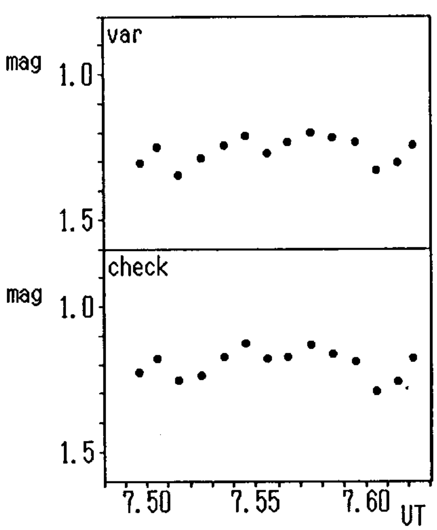
Significant difference between the spectroscopic and the photometric periods may lead to an idea that these two periods are essentially different, as observed as the superhumps of the SU UMa systems or the beat periods of the intermediate polars. In these cases, high orbital inclination is not necessary. In the cases (b) and (c), the amplitude of the variability may be variable, because the heating of the secondary may be changing as suggested by Howell and Shafter (1990). Further spectroscopic and multi-wavelength observations are required to improve the period as well as to check the stability of the light curve.

Table I.

	V404 Cyg				Check		
UT(Geo) Aug.,1990	Δm	SD	n	UT(Geo) Aug.,1990	Δm	SD	n
6.4685	1.29	0.12	3	6.4685	1.20	0.03	3
6.4752	1.33	0.08	10	6.4752	1.17	0.10	10
6.4854	1.32	0.13	9	6.4858	1.15	0.11	8
6.4950	1.32	0.10	9	6.4950	1.16	0.12	9
6.5051	1.27	0.06	10	6.5051	1.18	0.12	10
6.5148	1.31	0.09	9	6.5148	1.24	0.09	9
6.5250	1.35	0.05	10	6.5250	1.21	0.10	10
6.5347	1.32	0.10	9	6.5347	1.28	0.08	9
6.5447	1.22	0.05	10	6.5447	1.19	0.06	10
6.5551	1.23	0.05	10	6.5551	1.19	0.04	10
6.5649	1.18	0.05	9	6.5649	1.22	0.04	9
6.5750	1.14	0.03	10	6.5750	1.19	0.08	10
6.5849	1.07	0.03	5	6.5849	1.16	0.06	5
6.5950	1.11	0.05	6	6.5950	1.17	0.05	6
6.6055	1.11	0.06	6	6.6055	1.17	0.05	6
6.6149	1.11	0.05	4	6.6149	1.14	0.04	4
6.6245	1.11	0.04	6	6.6245	1.19	0.04	6
6.6351	1.16	0.03	6	6.6351	1.16	0.05	6
6.6455	1.18	0.04	6	6.6455	1.17	0.06	6
6.6548	1.15	0.09	10	6.6548	1.19	0.08	10
6.6648	1.17	0.07	10	6.6648	1.18	0.13	10
6.6751	1.25	0.10	10	6.6751	1.20	0.11	10
6.6849	1.27	0.05	9	6.6849	1.29	0.11	9
6.6952	1.32	0.10	8	6.6952	1.15	0.05	8
6.7052	1.31	0.08	10	6.7052	1.26	0.08	10
6.7153	1.32	0.08	10	6.7153	1.21	0.10	10
6.7255	1.24	0.10	10	6.7255	1.20	0.17	10
6.7351	1.40	0.10	9	6.7351	1.16	0.13	9
6.7433	1.34	0.11	6	6.7433	1.11	0.12	6
6.7550	1.18	0.13	9	6.7550	1.16	0.17	9
6.7649	1.34	0.12	9	6.7645	1.18	0.13	10
6.7738	1.25	0.05	8	6.7738	1.19	0.06	8
6.7872	1.23	0.09	5	6.7872	1.28	0.06	5
6.7949	1.19	0.09	9	6.7946	1.19	0.14	10
6.8007	1.27	0.09	2	6.8007	1.36	0.07	2
7.4972	1.30	0.12	5	7.4965	1.23	0.04	6
7.5051	1.25	0.08	7	7.5051	1.18	0.05	7
7.5149	1.35	0.10	7	7.5149	1.25	0.09	7
7.5251	1.29	0.08	8	7.5251	1.24	0.06	8
7.5356	1.25	0.04	7	7.5356	1.17	0.06	7
7.5456	1.22	0.05	7	7.5456	1.13	0.06	7
7.5550	1.27	0.08	7	7.5550	1.18	0.06	7
7.5644	1.23	0.10	7	7.5644	1.18	0.10	7
7.5750	1.20	0.05	8	7.5750	1.13	0.06	8
7.5845	1.22	0.04	6	7.5845	1.17	0.03	6
7.5952	1.23	0.06	8	7.5952	1.19	0.10	8
7.6050	1.33	0.05	2	7.6050	1.29	0.08	2
7.6147	1.30	0.09	8	7.6147	1.26	0.04	8
7.6221	1.25	0.03	3	7.6221	1.18	0.04	3

August 6, 1990.





August 7, 1990.

Figure 1.

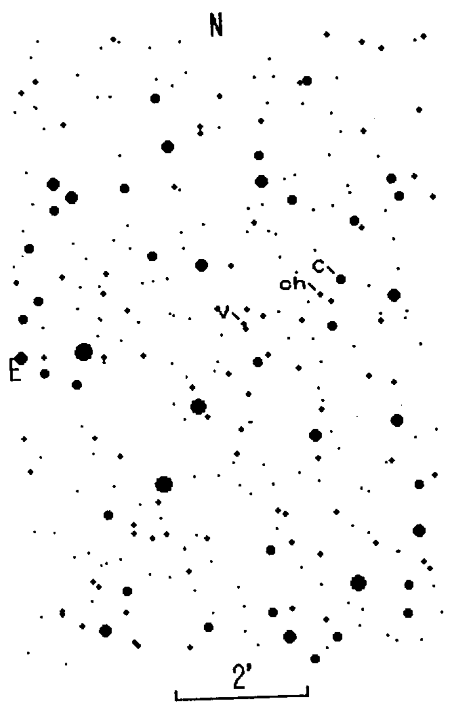


Figure 2.

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