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ORBITAL LIGHT CURVE AND PARAMETERS OF X-RAY NOVA GS2023+338=V404 Cyg

The X-ray nova GS2023+338=V404 Cyg has been discovered as the best black hole candidate by recent spectroscopic investigations (Charles, 1991; Casares et al., 1992) with the orbital period $P = 6^d.47259 \pm 0^d.0009$ and mass function

$$f_v(\mathcal{M}) = \frac{\mathcal{M}_x^3 \sin^3 i}{(\mathcal{M}_x + \mathcal{M}_v)^2} = 6.26\mathcal{M}_\odot.$$

In this paper we present the optical orbital light curve of V404 Cyg in quiet stage (V = 19 ^{m}) that is in good agreement with the radial velocity curve (Casares et al., 1992) in the model of a close binary system.

Photometric observations have been obtained at the 50−cm telescope equipped with a television device in Crimean Astrophysical Observatory (Abramenko et al., 1983). During 5 nights 170 individual observations were obtained in 1991 when the system V404 Cygni was at quiet stage (V=19^m). The convolution of the average nightly values of the light of V404 Cyg with the spectroscopic orbital period (Casares et al., 1992) P=$6^d.47259$ and zero phase JD 2448477.353 (optical G-K star is in front) is presented in Figure 1. The mean light curve is given in Table 1. The magnitude differences refer to the brighter comparison star (No. 1 in Figure 2). A considerable (~$0^m.3$) ellipticity effect of the optical G-K star is observed. Minima in the light of V404 Cyg are observed at the phases 0 and 0.5, which proves the fact that the radial velocity curve obtained for the G-K star by Casares et al. (1992) reflects the orbital motion of this star. So our photometric data proves correctness of the mass function determination for V404 Cyg $f_v(\mathcal{M}) = -6.26\mathcal{M}_\odot$ obtained by Charles (1991) and Casares et al. (1992). Because of the considerable ellipticity effect observed, we can conclude that the G-K star is the donor contributing the accreting matter onto the black hole.

Interpretation of the optical light curve of V404 Cyg in the framework of the standard model of X-ray binaries (Antokhina, 1988; Goncharsky et al., 1991) allows us to estimate the values of the parameters of V404 Cyg binary system: inclination of the orbital plane i = 45°−70°; mass ratio $q = \mathcal{M}_x/\mathcal{M}_v = 4.5 - 2.6$ accordingly; orbital separation of the components: a=46−39 $R_\odot$, mass of the black hole candidate $\mathcal{M}_x = 27 - 14\mathcal{M}_\odot$, mass of the visible star (which according to our results is a K0III star with the radius of about 12 $R_\odot$, but not G9V star) is $\mathcal{M}_v = 6 - 5\mathcal{M}_\odot$. The computer simulated model of V404 Cyg is presented in Figure 3. Our results confirm the conclusion of Charles (1991) and Casares et al. (1992) that V404 Cyg is the best black hole candidate.

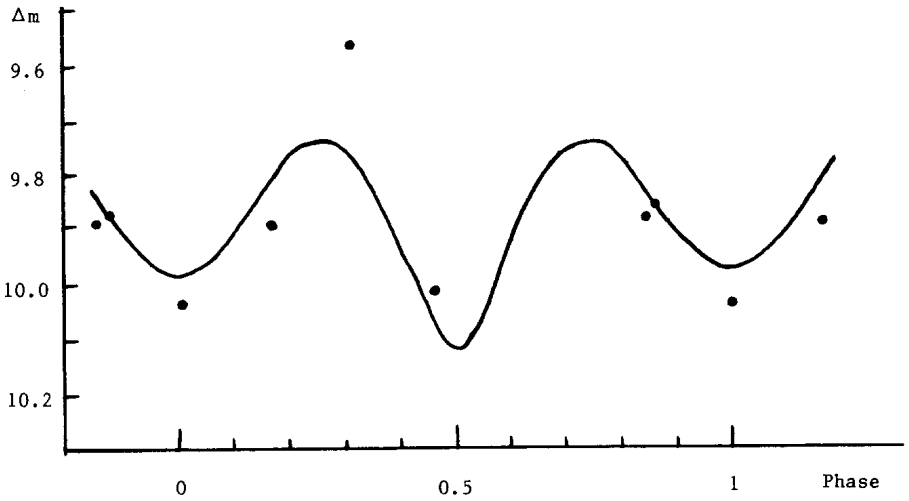

Figure 1. Observed (points) and theoretical (line) light curve of V404 Cyg. The theoretical curve corresponds to the mass ratio q=3 and inclination i=70°.

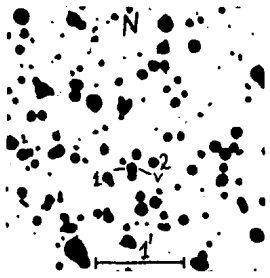

Figure 2. Finding chart for V404 Cyg. The magnitude of the star No. 1 is 19.65B, that of the star No. 2 is 20.4B.

Table I. Mean light curve of V404 Cyg.

Phase	Δm	σ	N
0.00	$0^m.04$	$0^m.02$	43
0.17	−0.11	0.09	11
0.31	−0.44	0.02	33
0.46	0.01	0.02	31
0.85	−0.12	0.03	9
0.86	−0.15	0.02	23

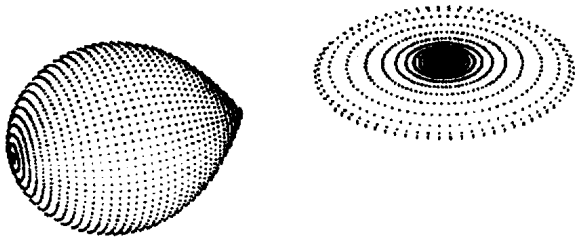

Figure 3. Computer simulated picture of the model for V404 Cyg

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