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

Number 5011

Konkoly Observatory
Budapest
29 December 2000

HU ISSN 0374 – 0676

1994 BV PHOTOELECTRIC OBSERVATIONS OF CG Cyg

DAPERGOLAS, A.[1]; KONTIZAS, E.[1]; KONTIZAS, M.[2]

[1] National Observatory of Athens, Institute of Astronomy and Astrophysics, I. Metaxa and Vas. Paulou, Palaia Penteli, GR–152 36, Athens, Greece, e-mail: adaperg@astro.noa.gr; ekonti@astro.noa.gr

[2] Section of Astrophysics Astronomy and Mechanics, Department of Physics, University of Athens, GR–157 83, Athens, Greece, email: mkontiza@cc.uoa.gr

Photometric observations for CG Cyg have been reported previously by Dapergolas et al. (1994); Heckert (1994); Zeilik et al. (1994) and references therein. The star is among the most peculiar ones of the short-period chromospherically active binary stars. As noted by Dapergolas et al. (1994) the system presents irregularities outside of the eclipses and the depths of the minima changes with time. All these suggests that CG Cyg is a complex system, with changing active regions, due probably to photospheric activity.

CG Cyg was observed for the period 4–16 August 1994 with the 1.2-m Kryonerion telescope and a single channel photon counting photometer described by Dapergolas and Korakitis (1987). The photometer employs a high gain 9789QB phototube and conventional B, V filters. Its output is fed to a microcomputer enabling rapid data access. The data reduction method is the standard one and as a comparison star BD $+34°4216$ was used. The constancy of the comparison star was verified by Milone et al. (1979). The data presented here were obtained with an accuracy of $\pm0\overset{\mathrm{m}}{.}015$. Table 1 lists the dates of observations and phases covered and number of points obtained. Our observations where nearly simultaneous with those of Heckert (1994).

In Table 2 the times of minima and the $O-C$ values are listed for the V and B bands, respectively. Times of minima are calculated using the method described by Kwee and van Woerden (1956) whereas the $O-C$ values were determined from the linear ephemeris $\mathrm{HJD}_{\mathrm{min\,I}} = 2439425.1221 + 0\overset{\mathrm{d}}{.}631141 \times E$, given by Milone and Ziebarth (1974).

The data are modeled using the Information Limit Optimization Technique (ILOT) described by Budding and Zeilik (1987). The main assumptions of the ILOT are: (1) the activity in general is most apparent in the hotter (primary) star, (2) maculation effects are separable from proximity and eclipse effects, and (3) a cool circular spot model adequately represents the key parameters of stellar magnetic activity–these are longitude, latitude, size (area), and temperature of the active (spotted) regions.

The derived residuals from the initial fit of Fig. 1a are plotted in Fig. 1c. Then into the distortion wave a circular spot of 0 K temperature was fitted. The results are seen in Table 3. The fits are performed independently for both colours V and B. The results of the spot fitting agree, within the errors, to those found by Zeilik et al. (1994) and Heckert (1994). It is found that the spot for CG Cyg tend to cluster in Active Longitude Belt, around the 270° as it is noticed by Zeilik et al. (1994). We tested several times to fit a

Table 1: Dates of observations and phases covered

JD 2440000 +	Date	Phase	Points V	Points B
9569	04 August 1994	.77 .12	95	81
9570	05 August 1994	.36 .78	113	110
9572	07 August 1994	.56 .84	92	93
9577	12 August 1994	.45 .88	111	113
9578	13 August 1994	.01 .48	134	132
9579	14 August 1994	.67 .09	112	112
9581	16 August 1994	.78 .14	92	91

Table 2: Types and times of minima

Date	Type	V colour HJD 2440000 +	V colour $O-C$	B colour HJD 2440000 +	B colour $O-C$
4/8/1994	I	$9569.4836 \pm .0002$	0.051	$9569.4837 \pm .0001$	0.051
5/8/1994	II	$9570.4324 \pm .0012$	0.554	$9570.4323 \pm .0004$	0.554
12/8/1994	II	$9577.3740 \pm .0006$	0.553	$9577.3742 \pm .0005$	0.553
13/8/1994	I	$9578.3197 \pm .0003$	0.051	$9578.3199 \pm .0001$	0.051
14/8/1994	I	$9579.5821 \pm .0001$	0.051	$9579.5821 \pm .0001$	0.051
16/8/1994	I	$9581.4758 \pm .0002$	0.052	$9581.4758 \pm .0002$	0.052

Table 3: CG Cyg spot parameters

		V band	B band
Longitude	λ_1	276.7 ± 8.0	286.6 ± 7.6
Latitude	β_1	56.2 ± 33.6	62.1 ± 20.3
Radius	γ_1	10.4 ± 4.8	12.0 ± 4.5
χ^2		84.6	87.

Table 4: CG Cyg clean parameters

Filter	L_1	$k = r_2/r_1$	$\Delta\theta_0$	r_1	i (deg)	L_2	χ^2
V	$0.689 \pm .030$	$0.936 \pm .056$	-18.37 ± 0.1	$0.240 \pm .006$	$82.2 \pm .4$	$0.288 \pm .046$	80.5
B	$40.707 \pm .023$	$0.956 \pm .045$	-18.37 ± 0.1	$0.237 \pm .005$	$82.1 \pm .3$	$0.273 \pm .004$	80.8

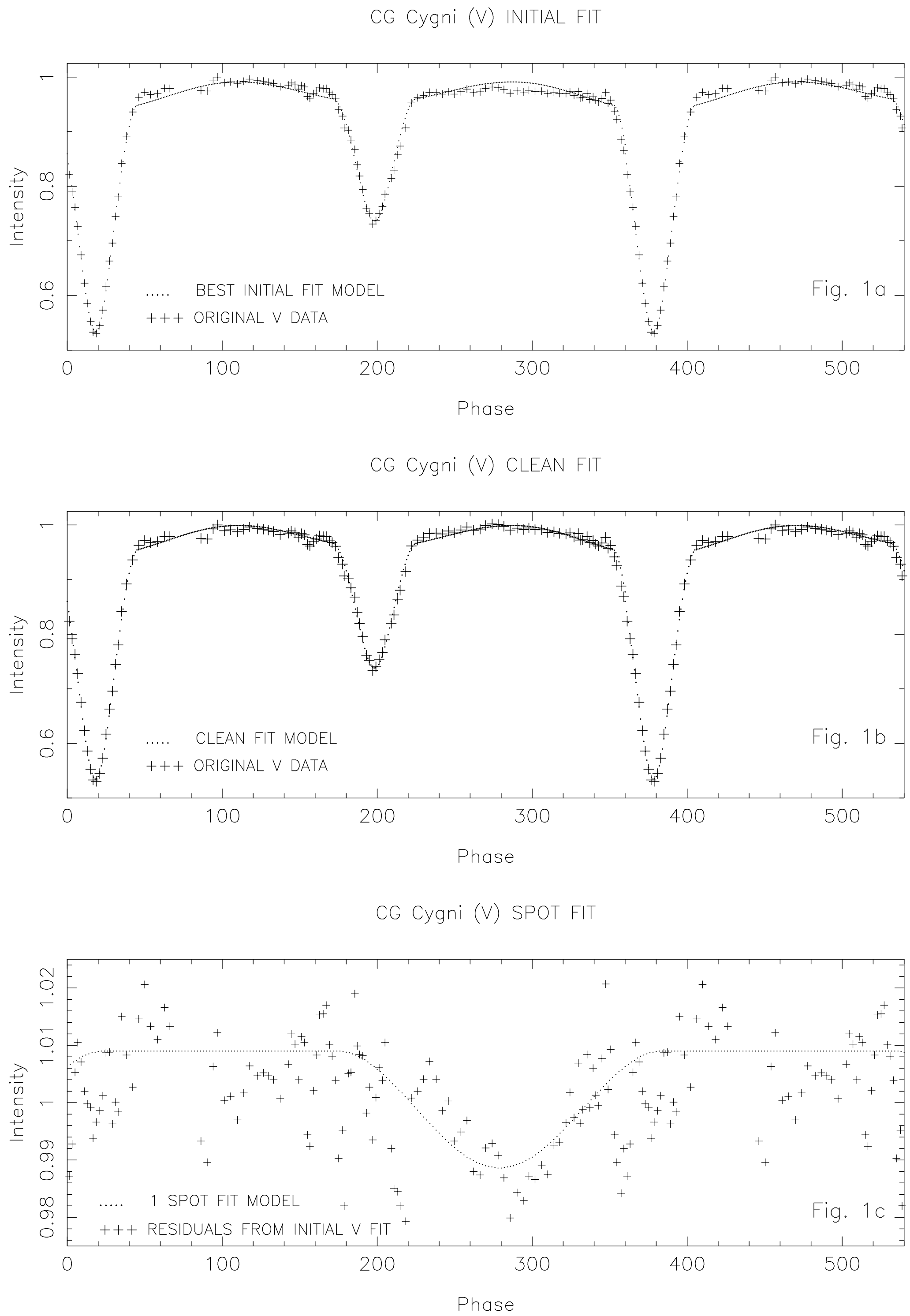

Figure 1. Initial, clean and spot fits. Phases are given in degrees

second spot with fixed latitude at 45°, as it is described by Heckert (1994), but the results were very uncertain. This result means that our data sample with $S/N \approx 75$ is unable to detect small spots. This is in agreement with a series of verification tests of the ILOT programs reported by Rhodes et al. (1990). However, a small distorsion in the observed light curve of the star is seen toward the first quadrature of the system (see spot fit in Fig. 1c). This distorsion was more evident a few days later when the star was observed from Mt. Laguna with the 61-cm telescope (Heckert 2000) and clearly showed a second spot.

The results of spot fitting where inserted in the initial fit model and a clean fits was made (Fig. 1b). So the distortion wave was removed and the clean parameters are seen in Table 4. The values of L_1, k, r_1, i (deg), and L_2 agree with those found by Zeilik et al. (1994) and Heckert (1994). From the results presented in Table 4 assuming constant inclination i and phase correction $\Delta\theta_0$ the mass ratio $q = m_2/m_1$ of the system can be derived. For V colour and for B the values of mass ratio are $q = 0.571 \pm 0.108$ and $q = 0.647 \pm 0.089$ respectively. These values are in agreement with those found by Heckert (1994) and Popper (1993), and strengthen the hypothesis that the mass ratio of CG Cyg is lower than 1.0.

From our data set it seems that CG Cyg changes its spot structure rather rapidly and probably is one of the most active RS CVn type binary system.

The authors would like to acknowledge the Greek General Secretariat of Research and Technology for financial support and one of the authors, D. A., wishes to express his sincere thanks to Dr. P. Heckert for his helpful suggestions.

References:

Budding, E., and Zeilik, M., 1987, *Astrophys. J.*, **319**, 827

Dapergolas, A., Kontizas, E., and Kontizas, M., 1994, *IBVS*, No. 4051

Dapergolas, A., and Korakitis, R., 1987, *Pub. Nat. Obs. of Athens*, Series II, No. 28

Heckert, P., 1994, *IBVS*, No. 4127

Heckert, P., 2000, private communication

Kwee, K.K., and Van Woerden, K.E., 1956, *Bull. Astr. Inst. Netherlands*, **12**, 327

Milone, E.F., and Ziebarth, K.E., 1974, *Publ. Astron. Soc. Pacific*, **86**, 684

Milone, E.F., Castle., K.G., Swadrom, D., Burke, E.W., Hall, D.S., Michlovic, J.E., and Zissell, R.E., 1979, *Astron. J.*, **84**, 417

Popper, D.M., 1993, *Astrophys. J.*, **404**, L67

Rhodes, M., Budding, E., and Zeilik, M., 1990 in *Cool stars, stellar systems, and the Sun*, Proceedings of the 6th Cambridge Workshop, Astr. Soc. of the Pacific, p. 252

Zeilik, K., Gordon, S., Jaderlund, E., Ledlow, M., Summers, D.L., Heckert, P.A., Budding, E., and Banks, T.S., 1994, *Astrophys. J.*, **421**, 303