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1997 PHOTOMETRY OF CG CYGNI

PAUL A. HECKERT

Dept. of Chem. & Physics, Western Carolina University, Cullowhee, NC 28723 USA

CG Cygni (= # 177 in the catalog of Strassmeier et al. 1993) is a short period eclipsing RS CVn system. Zeilik et al. (1994) model the available data from 1922 to 1993. They also review the literature on this system. Dapergolas et al. (1994 and previous work) have done considerable recent B and V photometry of this system. Heckert (1994, 1995) model 1994 and 1995 light curves of this system. This work continues with the 1997 light curves.

I observed CG Cyg on the nights of 9, 12, 13, 14, 15, and 16 August 1997 with the San Diego State University 61-cm telescope on Mt. Laguna. The photometer and observing techniques are the same as for Heckert (1994). The light curves, with 144 data points in each filter, are plotted in Figures 1 and 2 in the standard Johnson–Cousins system. The phases are computed using the ephemerides of Sowell et al. (1987). The small amplitude out-of-eclipse variations discussed by Zeilik et al. (1994) are not visible in these 1997 light curves. These variations are observed as recently as 1994 and to a lesser extent 1995 (Dapergolas et al. 1994, Heckert 1994, 1995).

Using Budding and Zeilik's (1987) Information Limit Optimization Technique (ILOT), I modeled the data. Briefly, the ILOT extracts a distortion wave from the initial binary fit. This wave is then fit for two circular 0K spots. The fits for each color are performed independently. Figures 3 and 4 show the V band fits. The latitude is the most difficult spot parameter to fit. When unable to fit the latitude of the second spot, I fixed the value where it seemed to be converging in trial fits. Such values have no reported error bars in the table below. The reported longitude, latitude and radius of each spot are in degrees. I get:

Spot Fits

	B band	V band	R band	I band
Longitude_1	98.6±2.5	103.7±4.5	105.4±4.8	104.0±5.7
Latitude_1	70.2±3.2	68.6±5.8	70.5±4.0	72.6±4.7
Radius_1	31.8±3.0	28.0±4.5	27.8±3.4	27.7±4.4
Longitude_2	221.5±7.4	213.5±15.9	216.9±11.8	211.8±11.4
Latitude_2	0	0	−5.9±79.4	20
Radius_2	8.8±0.7	7.8±1.1	8.3±1.8	8.2±1.3
χ^2	233.8	179.9	175.0	131.0

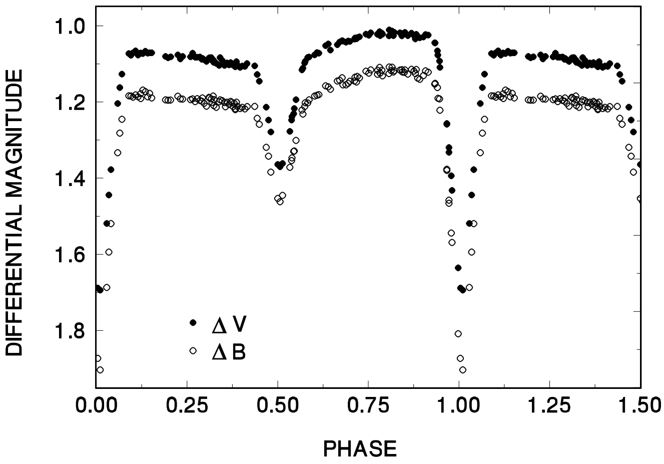

Figure 1.

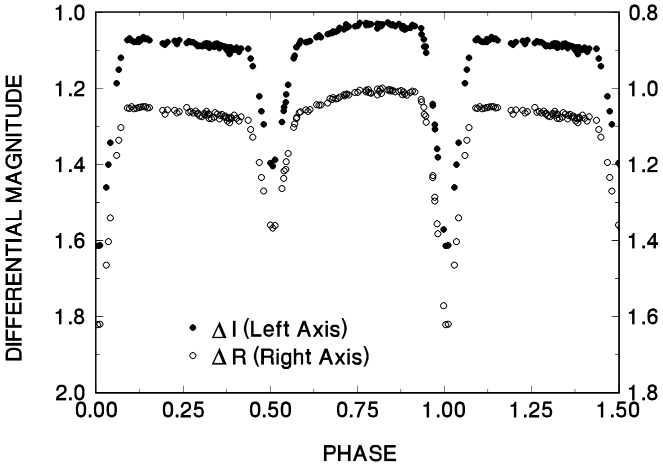

Figure 2.

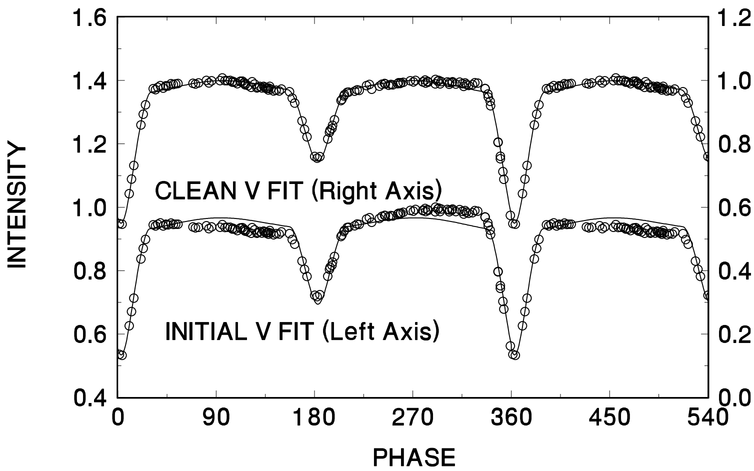

Figure 3.

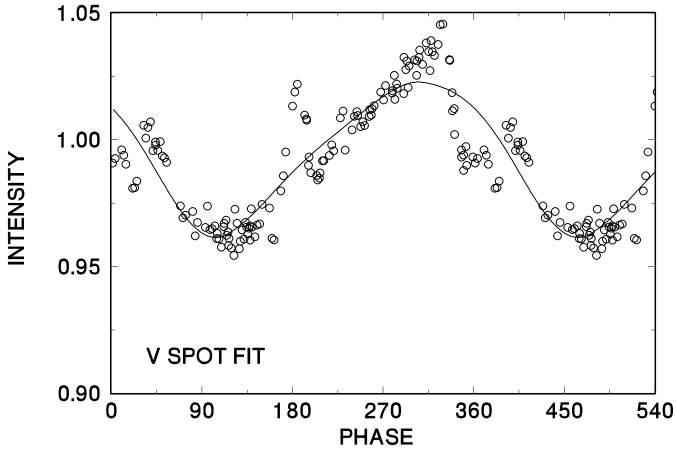

Figure 4.

During 1997 there was a spot in each Active Longitude Belt. The spot in the 90° ALB was a fairly large high latitude spot. The 270° ALB contained a smaller low latitude spot. Both of these spots are new rather than one of the spots found in the 1995 or 1994 light curves (Heckert 1994,1995). A small low latitude spot is in the 270° ALB, which had a large high latitude spot in 1995. Spots on the sun tend to disperse and reform at different latitudes rather than migrate in latitude. Hence, this spot is likely a new spot rather than a spot that changed size and migrated. The 90° ALB had a large high latitude spot in 1997 but no spot in 1995.

After performing the spot fits, I performed clean fits to the light curves with the effects of the distortion wave removed. I get:

Clean Fits

	B band	V band	R band	I band
L_1	0.747±0.010	0.716±0.013	0.718±0.012	0.724±0.059
$k(=r_2/r_1)$	0.831±0.018	0.837±0.022	0.805±0.021	0.767±0.115
$\Delta\theta_0$	−2.997±0.114	−2.968±0.122	−2.884±0.126	−2.840±0.129
r_1	0.256±0.005	0.255±0.005	0.259±0.005	0.261±0.016
i(deg)	83.3	82.8	82.8	83.1±1.6
L_2	0.236±0.011	0.266±0.014	0.270±0.013	0.269±0.061
$q(=m_2/m_1)$	0.393±0.056	0.411±0.078	0.386±0.090	0.353±0.206
χ^2	132.3	90.1	88.7	66.0

As defined by Budding and Zeilik (1987), L_1 and L_2 are the fractional luminosities of the primary and secondary star. They are normalized to sum to approximately but not exactly one. The inclination, i, is in degrees. k and q are the ratios of the radii and masses. The radius of the primary, r_1, is in units of the orbital separation. $\Delta\theta_0$ is the difference between the observed and computed times when the eclipses occur expressed in degrees. Averaging the values of $\Delta\theta_0$ for the different filters, and converting into days I find that the eclipses occurred 0.0051±0.0001 days after they are predicted to occur during this epoch. This difference is very similar to that observed in 1995 but differs from 1994 (Heckert 1994, 1995).

The mass ratio, q, is much lower than for previous work. Popper (1993, 1994) get 0.84 and 0.86, Jassur (1980) gets 0.95, Heckert (1994, 1995) get 0.53 and 0.81. Most other previous workers get 1.0 (Budding and Zeilik 1987, Zeilik et al. 1994, Naftilan and Milone 1985, and Sowell et al. 1987). The average value for the four 1997 light curves is 0.39. Mass ratios found by analysis of light curves are less reliable than those found from spectral data. However the fact that the 1997 as well as the 1994 and 1995 light curves all yield low values for the mass ratio suggests that the previously reported values lower than 1.0 are more likely to be correct than the more commonly reported values of 1.0.

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