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# A PHOTOMETRIC INVESTIGATION OF A CLOSE BINARY SYSTEM: YY Cnc

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YY Cnc (BD+31 1838, $V_{max}$=11.3 mag) was discovered by Hoffmeister (1949). Coordinates and identification for this and other Sonneberg variables in the MVS 308-316 were given by Kinnunen and Skiff (2000). The third edition of the General Catalogue of Variable Stars gives only the epoch of the primary minimum and the period of 0.55 days. The spectral type is listed as F2 both in the GCVS and the ADS database.

We present first ever obtained photometric light curves taken at the Mt. Suhora Observatory with the 60 cm telescope and a three channel photometer equipped with the wide-band UBVR filters. The observations were gathered from 11/12 to 24/25 Feb 2003. GSC 2483 1211 was used as the comparison star. Additionally, to enlarge the time span, the primary minimum was observed with the same telescope and a SBIG ST10/XME CCD camera about a year later on January 27/28, 2004, and again with the three channel photometer on February 25/26, 2004. All measurements have been corrected for differential extinction and left in the instrumental, close to the Johnson-Morgan, system. We observed 5 primary and 1 secondary eclipses and determined their times using the Kwee-van Woerden method. These times are shown in Table 1. We found the period significantly longer than that listed in the GCVS. Using the new times of minima we determined a new linear ephemeris for YY Cnc:

$$\mathrm{HJD}_{\mathrm{prim.min.}}=2452695.5815(3) + 0.698448(2) * \mathrm{E}$$

Table 1. New times of minima for YY Cnc

| No. | Date | type | Time of minimum | Instrument |
|---|---|---|---|---|
| 1 | 12/13-02-2003 | sec | 2452683.3464(3) | p3ch |
| 2 | 13/14-02-2003 | prim | 2452684.4056(3) | p3ch |
| 3 | 24/25-02-2003 | prim | 2452695.5811(3) | p3ch |
| 4 | 27/28-03-2003 | prim | 2452726.3150(4) | p3ch |
| 5 | 26/27-01-2004 | prim | 2453031.5443(9) | CCD |
| 6 | 25/26-02-2004 | prim | 2453061.5680(4) | p3ch |

The observations were phased with the new ephemeris and we attempted to obtain a preliminary model for this star using the Wilson-Devinney code (Wilson 1979, 1993). In the first step we assumed the primary temperature to be 6700 K as corresponding to the F2 spectral type (6700 K, Harmanec 1988) and made a search for the best fit with the Monte Carlo algorithm. Theoretical values for the albedo and gravity darkening coefficients, appropriate for a convective envelope were assumed. The coefficients for the limb darkening were taken as functions of the temperature and wavelength from Díaz-Cordovés et al. (1995) and Claret et al. (1995) tables. We assumed that there is no third light in this system. Computations were done simultaneously for the BVR filters. Observations in the U filter were discarded due to their bigger scatter. With such assumptions the convergence was very slow and we performed more computations for a grid of the primary temperature between 6500 K and 10000 K with a 500 K step. It soon turned out that for higher temperatures the solutions converged very fast and we were able to obtain a better fit to observations, with the best solution for the primary temperature being 7500 K. The fits for both models (that for the primary temperature corresponding to the F2 spectral type ($T_1$=6700 K) is denoted by the dashed line and that for 7500 K by the solid line) are shown in Fig. 1, while the resulting parameters are presented in Table 2. Asterisks denote assumed parameters, while double asterisks mark those which were not adjusted but computed by the Wilson-Devinney code.

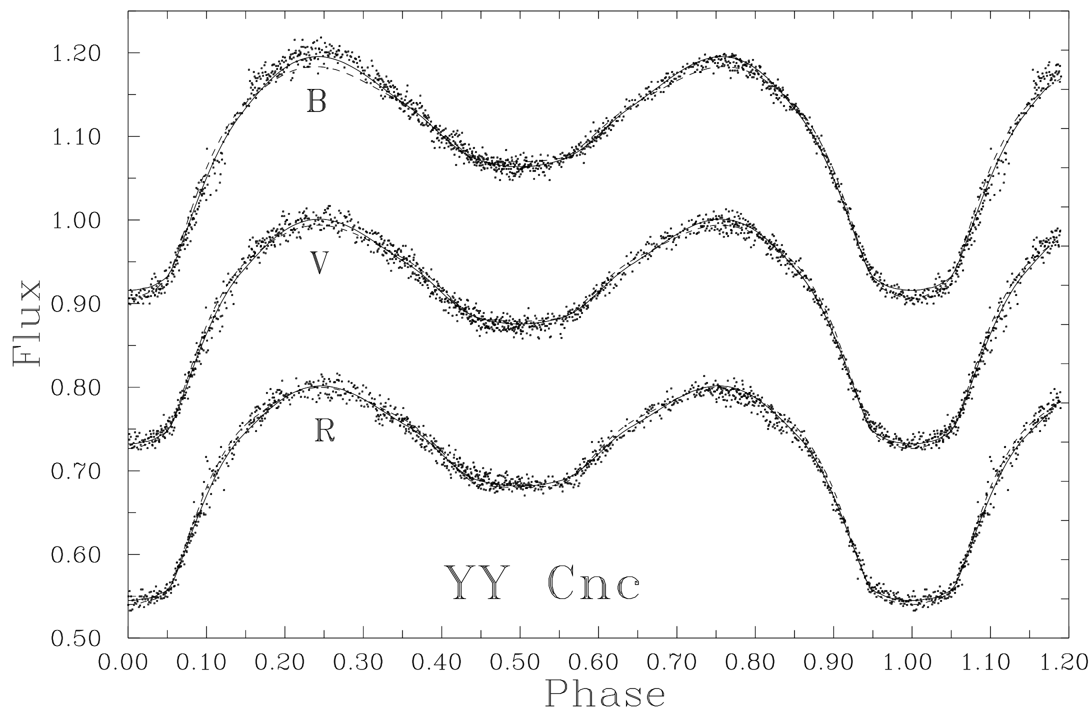


**Figure 1.** Comparison between observed (points) and theoretical (lines) light curves.

A significantly better fit (as measured by the $\chi^2$) was obtained for somewhat higher temperature of the primary component than that corresponding to the F2 spectral type listed for YY Cnc in the GCVS.

Both solutions indicate YY Cnc to be a close system with the hotter component almost filling its Roche lobe. The secondary component is well inside its Roche lobe. The system inclination is close to 90 degrees. The mass ratio is low, about 0.2 for both solutions, regardless of the assumed temperature of the hotter component, as may be indicated by the flat bottom shape of the secondary minimum. However, only spectroscopic observations could confirm our results derived on the basis of photometric measurements only.

Table 2. Results derived from the light curve modelling

| parameter | model 1 ($T_1$=6700 K) | model 2 ($T_1$=7500 K) |
|---|---|---|
| configuration | semi-detached | detached |
| phase shift | $-0.0006\pm0.0002$ | $-0.0003\pm0.0002$ |
| i (degrees) | $87.71\pm0.10$ | $89.45\pm1.03$ |
| $T_1$(K) | * 6700 | * 7500 |
| $T_2$(K) | $4510\pm30$ | $4010\pm40$ |
| $\Omega_1$ | $2.237\pm0.012$ | $2.182\pm0.014$ |
| $\Omega_2$ | $2.395\pm0.030$ | $2.256\pm0.029$ |
| $q_{phot}(m_2/m_1)$ | *$0.20\pm0.01$ | $0.18\pm0.01$ |
| $L_1$ ($B$) | $12.243\pm0.009$ | $12.864\pm0.016$ |
| $L_1$ ($V$) | $12.209\pm0.009$ | $12.819\pm0.013$ |
| $L_1$ ($R$) | $12.164\pm0.009$ | $12.715\pm0.012$ |
| $L_2$ ($B$) | ** 0.222 | ** 0.051 |
| $L_2$ ($V$) | ** 0.292 | ** 0.093 |
| $L_2$ ($R$) | ** 0.362 | ** 0.140 |
| $\chi^2$ | 781.5 | 271.6 |

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References:

Claret A., Díaz-Cordovés J., and Gimenez, A., 1995, *A&AS*, **114**, 247
Díaz-Cordovés J., Claret A., and Gimenez A., 1995, *A&AS*, **110**, 329
Harmanec P., 1988, *BAC*, **39**, 329
Hoffmeister, C., 1949, *Astron. Abh. Ergänzungshefte z.d. Astron. Nach.*, **12**, No. 1, A3
Kinnunen, T., Skiff, B., 2000, *IBVS*, No. 4906
Wilson R.E. 1979, *ApJ*, **234**, 1054
Wilson R.E. 1993, *Documentation of Eclipsing Binary Computer Model*