COMMISSION 27 OF THE I. A. U.
INFORMATION BULLETIN ON VARIABLE STARS
Number 2935

Konkoly Observatory
Budapest
19 September 1986
HU ISSN 0374 - 0676

PHOTOMETRY AND SPECTROSCOPY OF CH CYG IN 1985

CH Cygni is a well-known symbiotic star comprising an M7 giant and a hot component that is probably a white dwarf surrounded by an accretion disk. Taylor, Seaquist, and Mattei (1986) discovered that the system underwent a violent radio outburst in 1984-85 which produced a multi-component jet and concomitantly a decline is visual brightness. At the request of Dr. Seaquist we monitored the star photometrically and spectroscopically during the second half of 1985, and report our results here.

Our photometry was done with a two-telescope photoncounting system that allows the simultaneous measurement of the variable and a comparison star. HR 7381 was used as a comparison star, for which five nights of absolute photometry gave (y, b-y, m1, c1, β, V-R, V-I)=6.512, -0.019, 0.106, 0.820, 2.766, 0.009, -0.075) with internal standard errors all less than 0.007 mag. V-R and V-I are on the Cousins system.

Using these values the differential observations of CH Cyg were converted to absolute ones and are shown in Table I. Each is the mean of three observations, and the internal standard errors are all less than 0.01 mag, except for c1, where it is typically 0.03 mag.

Figure 1 shows the trend of the data with time. At the longer wavelengths, shown at the top of the diagram, the M-star is dominant and shows generally stable behaviour with a slight decline in light towards the end of our observations in early November 1985. Throughout this time the visual magnitude remained steady to within about 0.05 mag, but as one goes down the diagram to shorter wavelengths considerable brightening of the hot component becomes evident. The flux in the u-band increased sharply, reaching outburst proportions in October and November, and was 250% greater at the end of our observations than at the beginning. The β-index shows that Balmer emission, while steady during the earlier months, also increased dramatically in October/November.

Table I
PHOTOMETRY OF CH CYGNI IN 1985

HJD	y	b-y	m1	c1	β	V-R	V-I
2446000+							
199.704	7.631	1.686	-1.424	2.773	2.435	1.990	4.075
241.691	7.500	1.642	-1.263	2.411	2.416	1.942	3.949
258.685	7.552	1.632	-1.280	2.444	2.457	1.965	4.020
294.692	7.469	1.625	-1.197	2.238	2.439	1.919	3.952
354.530	7.603	1.552	-1.128	2.328	2.276	1.890	3.959
364.514	7.541	1.448	-1.036	1.971	2.155	1.833	3.870
377.607	7.565	1.347	-0.947	1.550	1.953	1.820	3.800

Between April 30 and November 11, spectra of CH Cygni were obtained in the blue from 3700-4950 Å (reciprocal dispersion 8 Å/mm on vacuum sensitized IIaO plates) and in the red from 5000-7000 Å (reciprocal dispersion 16 Å/mm on vacuum sensitized 098 plates) with the cassegrain spectrograph attached to the 1.88 meter telescope at the David Dunlap Observatory. Calibration plates were taken using the local version of the Latham (1969) spot sensitometer. The spectra were digitized with the Observatory's PDS microdensitometer and the digitized spectra were reduced to intensity versus heliocentric wavelength using standard techniques.

During this period, the spectrum of CH Cygni was that of a late M star on which a strong emission line spectrum was superimposed.

On our blue plates, hydrogen emission is apparent down to H11. (It may be present farther down but the exposures are weak in this region.) Relatively speaking, these emission lines are still fairly wide - excluding the spectra taken after the renewed photometric activity began, the basal width of the Hβ emission is 400 to 600 km/sec - but are much narrower than those reported by Tomov (1984) for 1984. Figure 2 shows the development of Hβ as seen on our material. Between May 4 and June 7,

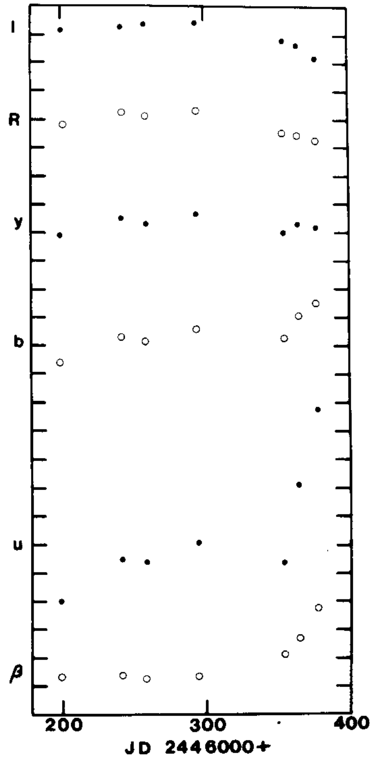

Figure 1. Brightness of CH Cyg in the Stromgren u,b,y and Cousins R,I bands during 1985. Tick marks on the vertical axis are 0.2 mag apart with brightness increasing upwards.

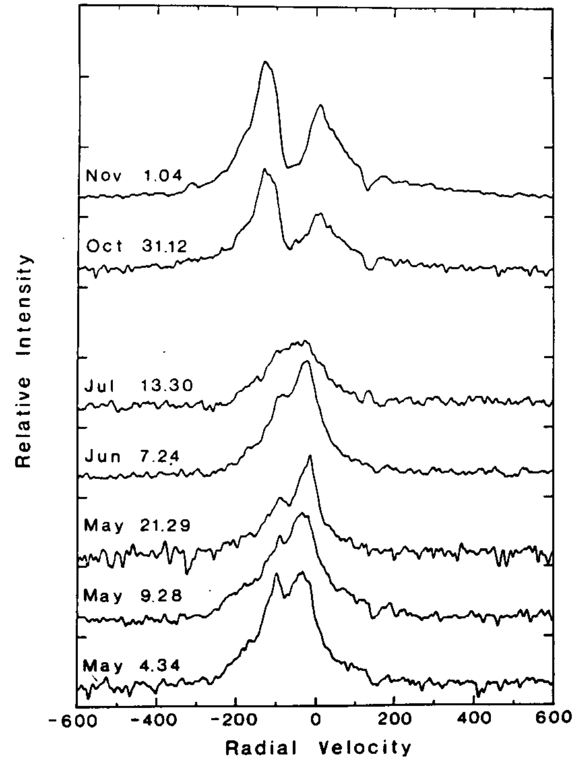

Figure 2. Hβ profiles observed in 1985 plotted against radial velocity. The profiles have been scaled so that the apparent continuum is similar on all the plots. The spectra were not normalized because the plates are weakly exposed at the continuum level and the continuum itself may be variable. The baseline for each plot is indicated by the tick marks immediately below it.

the central reversal became less noticeable as the violet component of the emission weakened. Subsequently, the red component appears to have weakened and on spectra taken July 13, 16 and 21, Hβ is essentially single. No further blue spectra were obtained until October 31. On this plate and one taken November 1, Hβ displays a strong central reversal and the violet component of the emission is stronger than the red. These latter two profiles are similar to those shown by Tomov (1984) for Hδ but lack the very broad emission wings found by Mikolajewski and Mikolajewski (1985) on spectra taken several days later. On October 31, the basal width of the Hβ emission was about 750 km/sec; on November 1, it had increased to about 900 km/sec. Throughout the period, Hα displayed a double-peaked profile. The V/R ratio was variable - prior to early August,

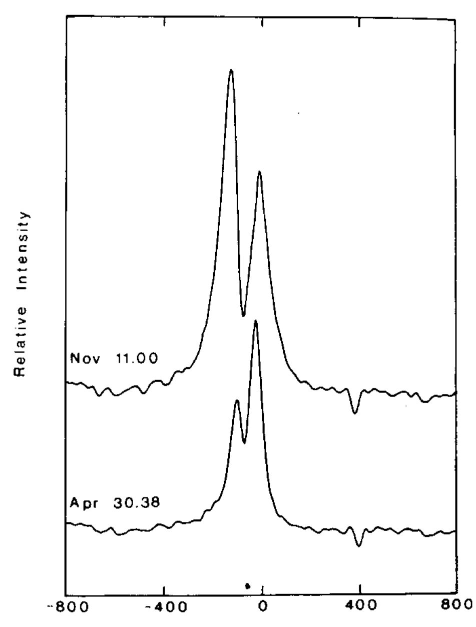

Figure 3. Two Hα profiles observed in 1985 plotted against radial velocity. The exposure level at the continuum was similar on these plates. Extrapolation of the calibration curve was not required to represent the emission peaks. No extensive emission wings are present.

it was <1; between mid-August and early October, the ratio tended to be >1 although on one occasion it reversed between exposures taken two nights apart; on our only November exposure, V/R was >1. (Unfortunately, many of these exposures are so strong at Hα that at least one of the the emission peaks is not well calibrated.) The velocity of the central absorption stayed around -70 km/sec. When compared with the pre-activity material (see Figure 3), the central reversal at Hα is more evident on the November plate and the basal width of the emission is slightly wider, about 550 km/sec. No extensive emission wings are apparent on this plate.

In addition to hydrogen, there are numerous other emission lines. Strong sharp lines of Fe II, [Fe II], [S II], [Ne III] and [O I] are present. There are no indications of any significant velocity differences between these lines. For our spectra, the mean velocities ranged from -50 to -60 km/sec. Weaker sharp lines of [O III] λ4363 and λ5007 are also present. Very weak He I λ3819 may be present on a couple of plates. The non-hydrogen emission line spectrum is similar on all our material.

Throughout the period, the late M-type absorption spectrum was visible. Mean velocities, measured mainly from the Fe I absorption lines, followed those of the sharp emission lines fairly well but were systematically more negative by 1-4 km/sec. (This may have arisen because most of the absorption lines are blended.)

.D. FERNIE, R. LYONS,
B. BEATTIE, R.F. GARRISON

David Dunlap Observatory,
Box 360, Richmond Hill,
Ontario, Canada L4C 4Y6

References:

Latham, D. 1969, A.A.S. Photobulletin, 1,3.

Mikolajewski, M., Mikolajewski, J. 1985 I.A.U. Circ., No. 4145.

Taylor, A.R., Seaquist, E.R., and Mattei, J.A. 1986, Nature, 319, 38.

Tomov, T. 1984, Inf. Bull. Var. Stars, No. 2610.