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Hα OBSERVATIONS OF T CrB

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The recurrent nova T Coronae Borealis is classified as a symbiotic star with one of the shortest orbital period, as well as the longest period cataclysmic variable. Hα observations have been obtained by Anupama & Prabhu (1991), Anupama (1997), and Hric et al. (1998). Variability and orbital modulation of the equivalent width were reported in these papers.

Here we present new Hα data acquired during the last years. The Hα observations of T CrB were obtained during the period February 1993–September 2000 with the Coudé spectrograph of the 2.0-m RCC telescope at the Bulgarian NAO "Rozhen" using different CCD detectors. The data processing has been done with the IRAF software package. The equivalent widths (EW) of the Hα emission lines are measured relatively to the local continuum and are summarized in Table 1. The typical error of the measurements is about 10 per cent.

Hereafter, we will use the spectroscopic ephemeris $T_0 = \mathrm{JD}\ 2447918.62 + 227\overset{\mathrm{d}}{.}5687 \times E$ of Fekel et al. (2000). The zero epoch corresponds to a time of maximum velocity of the red giant.

The long term behaviour of the EW(Hα) is presented in Fig. 1a. The data before JD 2448500 are from Anupama & Prabhu (1991). The data after it are our observations and four measurements by Mikołajewski et al. (1997). A new maximum is observed sometimes between JD 2450600–2450900 when the EW(Hα) reached values $\geq$ 20 Å. It decreased slowly to values $<$ 5 Å after this maximum. This behaviour is more or less similar to variability observed around JD 2447000. In both cases the EW reached values $\sim$ 30 Å and dropped to $<$ 5 Å on a time scale of about 1000 days, although the evolution in the former one seems to be slightly steeper.

The highest values in our data set are EW(Hα) $\geq$ 30 Å. It deserves to be noted that our highest values are at phase 0.36 of the $227\overset{\mathrm{d}}{.}5687$ period. Anupama & Prabhu (1991) observed extreme values at a close orbital phase, i.e. EW(Hα) $\geq$ 35 Å at JD 2446860, corresponding to orbital phase 0.35. Analyzing photographic and visual light curves, Peel (1990) discovered a tendency for short lived brightenings to occur at phases 0.33 and 0.20 (recalculated in terms of the ephemeris used here). The flare like events of 1963 and 1975 (see Palmer & Africano 1982 and references therein) are at phases 0.55 and 0.38 respectively. All these results support the idea that short lived eruptions occur sometimes, most probably around phase $\sim$ 0.35.

Table 1: Hα observations of T CrB

HJD 2400000 +	EW [Å]	HJD	EW	HJD	EW	HJD	EW
49024.62	7.5	50244.29	16.9	51007.41	13.4	51247.41	10.3
49027.62	6.4	50321.35	14.6	51028.28	14.9	51247.49	11.2
49180.49	3.1	50564.52	18.4	51028.37	13.9	51441.30	5.9
49225.43	6.8	50565.48	20.4	51029.28	14.9	51441.31	6.5
49353.63	5.7	50566.36	21.2	51029.35	14.9	51632.53	7.3
49353.65	5.8	50618.34	28.4	51030.35	15.1	51632.55	7.0
49356.64	4.4	50705.23	18.2	51030.36	14.6	51681.31	4.3
49376.54	3.7	50705.24	17.8	51031.26	14.0	51681.33	4.5
49491.51	3.2	50732.19	30.0	51031.28	14.4	51717.38	6.5
50115.55	5.3:	50732.21	31.3	51091.23	11.5	51742.30	4.2
50181.47	15.4	50881.48	13.8	51091.24	11.0	51742.32	4.6
50182.40	19.6	50919.45	20.8	51096.25	9.8	51774.27	5.4
50182.54	18.3	50919.50	21.0	51096.26	10.1	51774.28	5.5
50211.39	12.8	50923.48	20.7	51184.59	6.4	51775.31	4.7
50212.48	17.4	50969.30	13.4	51184.61	7.3	51805.27	2.4
50242.32	13.3	51004.29	12.7	51185.63	8.4		
50243.31	14.0	51005.40	11.9	51185.66	9.5		
50244.44	17.4	51006.43	13.6	51186.58	7.6		

It is difficult to say what can be the reason for this short flare like events. Most probably they are resulting from increase of mass transfer. However, the orbit is assumed to be almost circular, with eccentricity $e < 0.02$, and perhaps this is a spurious eccentricity, result of tidal effects (Kenyon & Garcia 1986; Belczyński & Mikołajewska 1998). In any case it is remarkable that the majority of the brightening events (of the EW(Hα) and the optical magnitude) takes place around ~ 0.35.

In the previous investigations, a modulation of the EW(Hα) with the orbital phase has been supposed (i.e. Hric et al. 1998). We performed periodogram analysis applying PDM (Stellingwerf 1978) and CLEAN (Roberts et al. 1987) algorithms. We used the whole data set and different subsets, with and without subtraction of fit to the data. The fits were low order polynomial over the whole data set or over the lower values only. Very weak traces of the orbital period are visible only when we use our data after removing the highest values, i.e. using only the points with EW $<$ 25 Å. The corresponding periodogram is plotted in Fig. 1b.

In Fig. 1c we plotted our data folded with the orbital period of 227.5687 days. In this panel the circles represent values less than 25 Å, and the crosses refer to EW $>$ 25 Å. As the crosses are very different from the other measurements, we suppose that the extreme values above 25 Å are caused by short lived brightenings. If we have in mind the circles only (i.e. EW $<$ 25 Å) two maxima appear to be visible. One is at phase about 0.9–1.2 and the second at 0.6. They are shifted relatively to the maxima detected by Hric et al. (1998), even if we use the same ephemeris. It is worth noting that in Fig. 1c the data are plotted without subtracting any fit. The fact that our maxima are shifted relatively to those detected by Hric et al. (1998) points out that the variability of the Hα induced by the binary rotation, is not very stable, if it exists at all. Hric et al. (1998) suggested that the orbital modulation of Hα might be a result of the presence of two other emitting

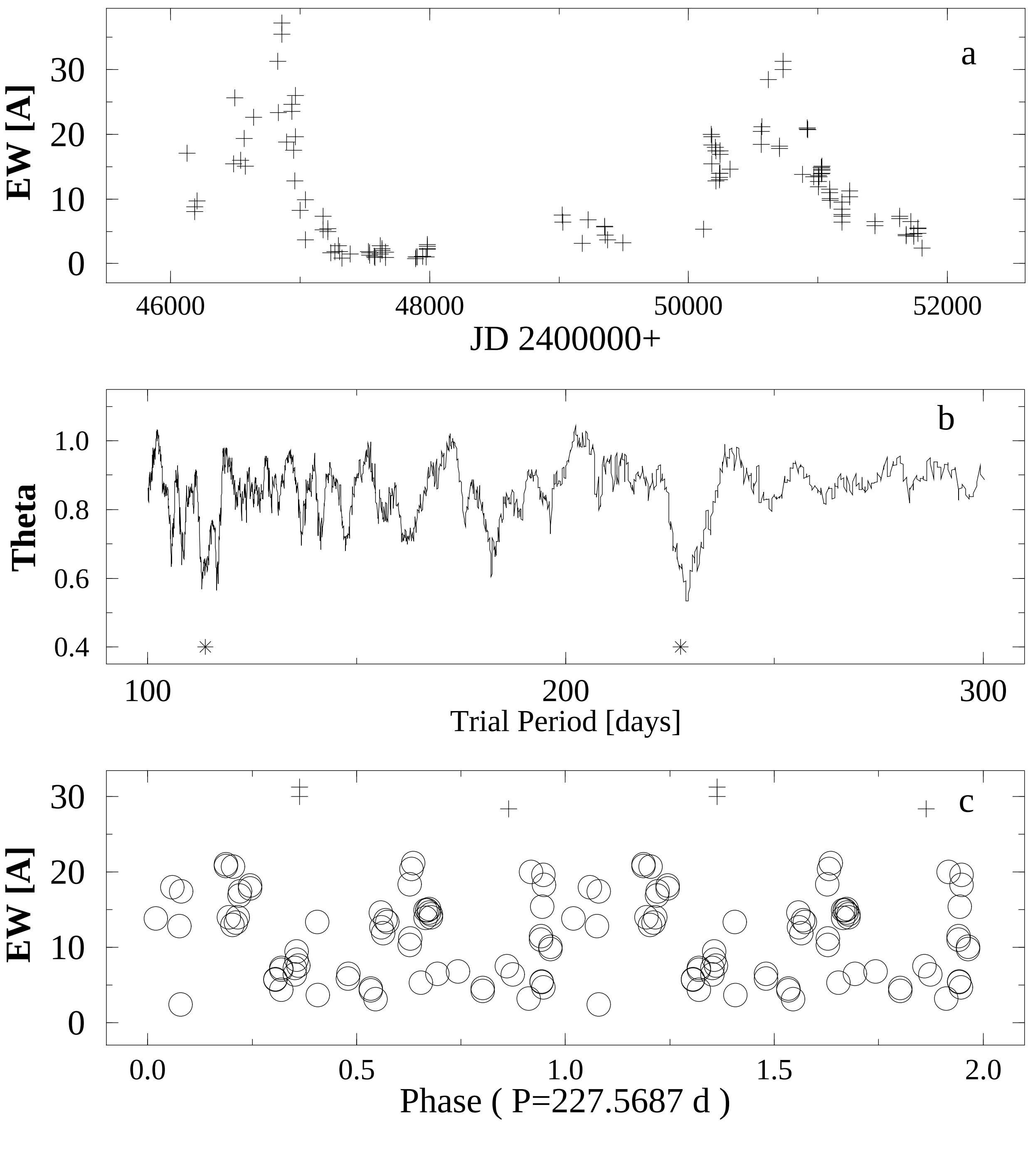

Figure 1. The EW(Hα) variability of T CrB. **a)** The long term behaviour. Two maxima are visible about JD 2446800 and about JD 2450700. **b)** Periodogram for the EW(Hα) using only our data and values less than 25 Å. The asterisks indicate the orbital and half orbital period. **c)** Our EW(Hα) observations folded with the orbital period. The circles refer to EW $<$ 25 Å, and the crosses refer to EW $>$ 25 Å

regions (which emission is superimposed on the emission of the accretion disk) — one identified with the gas stream through the inner Lagrangian point (L_1) and the second fed by matter rotating around the hot component but not captured by the accretion disk. The shift of our maxima as well as the big scatter indicate that the position of these two regions is probably variable. This could be a result of variability of the mass transfer rate, the angular momentum transfer rate, or/and variability of the size of the accretion disk.

It deserves noting that the IUE observations of the integrated UV-flux (1250–3200 Å) during the period JD 2446000–JD 2447200 do not exhibit considerable variations (Selvelli et al. 1992). In the same time (see Fig. 1a) the EW(Hα) shows an increase from 10 Å to 30 Å followed by a decrease to values less than 5 Å. Because the integrated UV flux is a good representation of the mass accretion rate, this points out that the variability of Hα is probably a result of changes in the angular momentum accretion rate and the size (and/or the structure) of the accretion disk rather than changes in the mass accretion rate.

High resolution observations and analysis of the Hα emission line profiles could throw a new light over this issue.

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