# OBSERVATION OF MASS LOSS IN R CrB DURING THE VISUAL LIGHT MINIMUM

N. Kameswara Rao
Indian Institute of Astrophysics, Bangalore, India

R CrB at minimum light shows three type of spectra: 1) an absorption line spectrum similar to that observed at maximum light; 2) a sharp emission line spectrum mainly due to singly ionised metals which is displaced to the blue by 3 to 10 $kms^{-1}$ with reference to the absorption spectrum observed at maximum. This is supposed to be a kind of permanent feature which exists even at the time of light maximum; 3) a broad emission line spectrum consisting of mainly $\lambda$3889 of HeI, H and K lines of CaII and the D lines of NaI. The widths of the broad emission features indicate expansion velocity of 200 $kms^{-1}$, much greater than the escape velocity (Gaposchkin 1963, Rao 1975).

These spectroscopic phenomena seem to be a common feature of all the cooler R CrB stars at the time of visual light minimum. Figure 1 illustrates several aspects of this broad emission features seen at the time of 1962 visual light minimum of R CrB. The spectral line profiles are derived from the spectrograms obtained by Dr. Herbig with 120-inch Shane telescope.

In the initial stages of the minimum, profiles look flat topped, which indicates that the gas might be optically thin. However, the ratio of flux in K and H lines of CaII is obtained as one. He $\lambda$3889 extends from +270 $kms^{-1}$ to -270 $kms^{-1}$. The CaII H and K lines extend from +310 $kms^{-1}$ to -310 $kms^{-1}$. As the minimum progresses the profiles become rounded with blue side getting steeper progressively. Secondly the center of the broad emission is shifted to the blue by 35-50 $kms^{-1}$ for all the three lines.

The observed flux in the H and K lines initially remains constant or increases slightly with time and later starts decreasing. But HeI $\lambda$3889 line emission shows a



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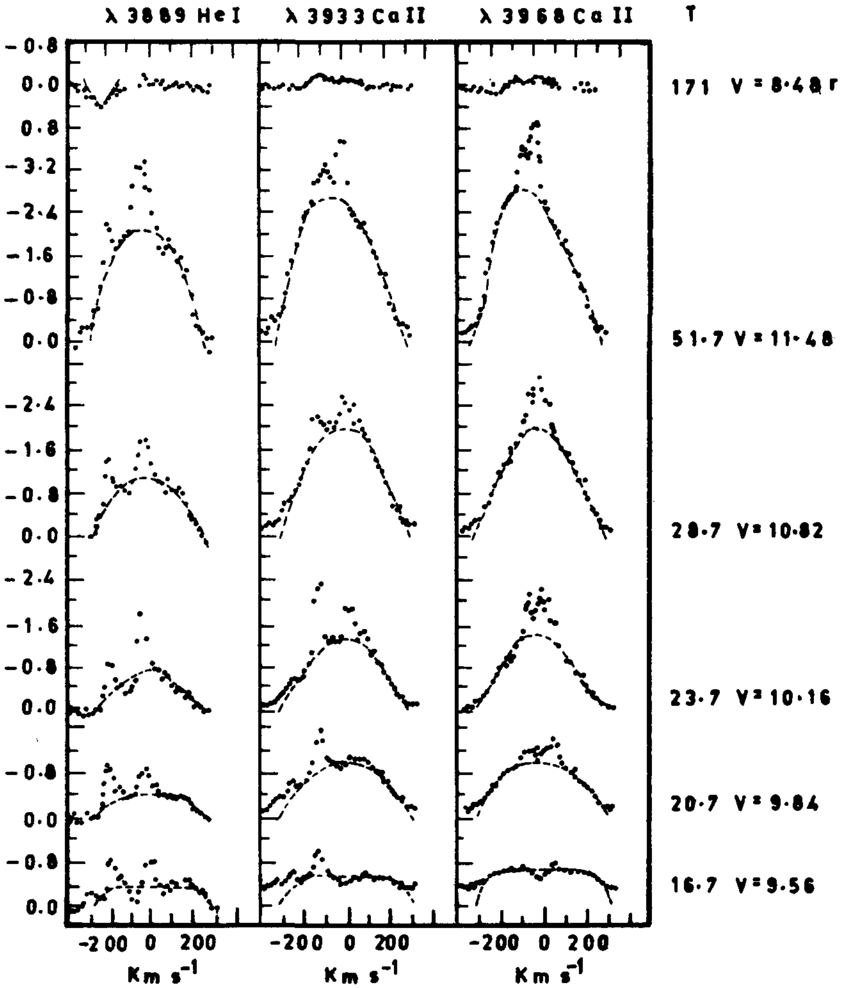


Figure: The profiles of HeI 3889, CaII H and K lines obtained in 1962 minimum at different phases (the dashed curves). T indicates the day from the start of the visual minimum and V the magnitude. The ordinate is $[(I_l/I_c)_{max} - (I_l/I_c)]$ where $I_l$ and $I_c$ are intensity in the line and continuum respectively. The profiles are plotted in velocity units with reference to the radial velocity observed at maximum light. The sharp emissions can be seen superposed on the broad emission line.

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continuous decrease as the minimum progresses. Throughout the minimum the intensities of both H and K lines appear roughly equal. At the end of the minimum, there exists an absorption component for HeI $\lambda 3889$ shifted by $-245$ kms$^{-1}$.

According to Herbig (1978 personal communication) the following HeI lines show broad emissions at the time of minimum light: $\lambda 10830$, $\lambda 7065$, $\lambda 7281$, $\lambda 3889$, $\lambda 6678$ and $\lambda 3187$. There is an indication that except for the mysterious absence of $\lambda 5876$, it is the low level lines of HeI that are present. The most puzzling thing is the absence of $\lambda 5876$ in emission. An upper limit to the flux of $\lambda 5876$ line emission is estimated to be equal to or less than that of $\lambda 3889$. Also $\lambda 7065$ seems to be stronger than $\lambda 5876$ from Herbig's observations.

Preliminary calculations show that such anomalous HeI line intensities can occur in electron collision dominated gas with $N_e \sim 10^{11}$ to $10^{12}$ for $T_e \sim 1 \times 10^4$K for high optical depths in the lines. The study of the broad emission lines seems to indicate that this gas is being ejected at the time of the light minimum semi-continuously and gets accelerated. The emission line region is probably optically thin and shows flat topped profiles in the beginning of the light minimum. As more gas is ejected and moves ahead of this emission region, the optical depth in the lines increases and the profiles become rounded.

Visual light minima of R CrB stars are thought to be caused by the formation of circumstellar dust. It has been observed at the time of the light minimum that there is difference in the reddening between the descending and the rising branches of the light curves. The extinction during the descending branch tends to be neutral with not much of colour change, while there occurs redder colours during the recovery part of the light curve (Forrest 1974). It is probable that the gas causing the broad emission lines with $N_e \sim 5 \times 10^{11}$ cm$^{-3}$ also produces the neutral extinction due to electron scattering. An extinction of 4.5 mag can result if this region is assumed to extend to $2R_*$ .

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