PRELIMINARY ANALYSIS OF THE BROAD He I EMISSION LINES IN R CrB

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ABSTRACT:
During light minimum phase, R CrB shows a broad emission line spectrum of He I including \( \lambda 10830, \lambda 7065, \lambda 7281, \lambda 3889, \lambda 6678 \) and \( \lambda 3188 \). But \( \lambda 5876 \) is very weak. The observed intensity ratios of \( I(\lambda 3889)/I(\lambda 5876) \) and \( I(\lambda 7065)/I(\lambda 5876) \) were greater than 1. The anomalous intensities of these lines appear to be due to optical depth effects. Preliminary analysis is presented to derive the physical conditions of the emitting gas.

I. INTRODUCTION

During the visual light minimum, R CrB shows three types of spectra: a) an absorption line spectrum similar to that observed at maximum light, b) A sharp emission line spectrum mainly due to singly ionized metals; the spectrum is displaced to the blue by 3 to 10 km/s with reference to the absorption spectrum observed at maximum, c) A broad emission line spectrum consisting of lines of He I, H and K lines of Ca II and the D lines of Na I. The He I lines seen are: \( \lambda 10830, \lambda 7065, \lambda 7281, \lambda 3889, \lambda 6678 \) and \( \lambda 3188 \). But \( \lambda 5876 \) is very weak. (see Fig.1). Typical line widths are as follows: He I \( \lambda 3889 \) extends from +270 km/s to -270 km/s. The Ca II H and K lines extend from +310 km/s to -310 km/s (Gaposchkin, 1963; Rao, 1981).

RY Sgr also shows such emission lines during minimum. Such anomalies in He I lines are also seen in V348 Sgr (Dahari and Osterbrock, 1984). It is likely that other R CrB type stars also exhibit similar phenomenon. These lines change their profiles as the minimum progresses.

We envisage a possible scenario as follows: A highly excited and electron collision-dominated gas is ejected at high velocities during light minimum. The emission lines probably arise from this and we attempt model calculations described in Sec. II to derive physical conditions of the gas cloud.
Fig. 1. Spectra of R CrB near $\lambda 5876$ region. The lower one was taken at minimum (11 July 1962) by G.H. Herbig when the star's $V$ magnitude was 10.0; the upper one was taken at maximum (11 April 1973).

Fig. 2. Energy level diagram for the model He I atom used for the NLTE calculations. Radiative transitions solved in detail are shown by arrows. For the calculations using the photon escape probability formalism, the continuum and the level 1's were not included.