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R CORONAE BOREALIS STARS: CHARACTERISTICS OF THEIR DECLINE PHASE

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Abstract. R Coronae Borealis (RCB) stars belong to a rare class of variable stars characterized by sudden and unpredictable declines, which are believed to be caused by dust cloud obscuration. Their evolution and the nature of their unpredictable minima are still not entirely understood. Very few observations of RCB stars during the decline phase exist. Only three RCB stars (R CrB, RY Sgr and V854 Cen) have been studied in detail and only a few declines have been completely covered by observations.

This thesis investigates the spectroscopic and photometric characteristics of RCB variables during their decline phases. A programme of photometric and spectroscopic observations of nine RCB and three HdC stars has been undertaken at Mt John University Observatory (MJUO) over a period of two and a half years.

The photometric observations have provided the *UBVRI* photometry and have served as a decline indicator. Complex colour changes during the declines were monitored and compared with the spectroscopy. An analysis of the photometry from the recovery phase of 26 different declines shows that the material causing the declines has extinction properties similar to those of the interstellar medium.

The medium and high-resolution spectroscopy has been obtained for six declines of different programme stars using the 1-m telescope at MJUO. Although the duration and depth of the declines are very different, they all show similar photometric and spectroscopic characteristics. The results have been compared with other observations and used to examine a simple line-region model (E_1/E_2/BL), which attempts to describe the evolution and origin of emission lines during a decline. In general, the evolution of various emission lines observed in this work is consistent with their classification into these three groups. However, some characteristics of the emission lines indicate a different origin from that suggested by the model.

Short-lived high-excitation lines from the initial decline phase (E_1), show a characteristic, shock-induced red shift indicating the photospheric origin. Lines classified as E_2, visible throughout whole decline, are slightly blue-shifted relative to the stellar velocity. The position of the E_2 line emitting region was estimated to be about $3\,R_* - 5\,R_*$. The broad emission lines (BL) are the strongest in V854 Cen, due to the significant amount of material produced by its frequent declines. The observations demonstrate that in contrast to the E_2 lines, whose fluxes have been found to decrease during the decline, the absolute flux of the broad lines stays constant throughout the whole decline phase. This is consistent with the idea that the broad emission is a permanent feature, whose visibility depends only on the photospheric brightness.

Various NaI D components (sharp and broad emission and high-velocity absorption) have been analysed in a number of RCB declines and presented in this thesis. The high-velocity blue-shifted NaI D absorption demonstrates similar velocities (between -230 kms^{-1} and

-400 kms^{-1}), structure and behaviour in the different declines. The observations clearly show that the high-velocity absorption lines can also appear during the initial decline phase. The spectroscopic observations of the 1998 decline of V854 Cen obtained in this thesis represent the first almost complete coverage of a decline of this star.