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The outer atmosphere of the RS CVn HR 7428

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Abstract. We infer informations on the physical properties of the atmosphere of the RS CVn binary system HR 7428 by means of semi-empirical atmospheric modeling. The nature of the HR 7428 H-α extra-absorption observed by many authors has been explored.

Key words. Stars: atmospheres – Stars: magnetic activity – Stars: radiative transfer

1. Introduction

HR 7428 (=V 1817 CYgni) is a spectroscopic RS CVn binary composed by a K2 II-III star and a main sequence A2 star. Marino et al. (2001) observed strong variability of H-α in width, intensity and shape, in particular, an excess of absorption, observed in the H-α wings, was interpreted by the authors as due to the presence of an inter-system cloud with turbulent velocities in the cloud up to 150 kms^{-1}.

2. Data acquisition and reduction

H-α and Na I D spectroscopic observations of HR 7428 have been obtained in 2001 at the 91-cm telescope of Catania Astrophysical Observatory, using an echelle R≈14,000 cross-configuration. Echelle IRAF packages have been used for data reduction, following the standard steps. The average S/N obtained at the continuum close to H-α is about 100. Mg II h&k spectroscopic observations have been obtained, in 1997, by the IUE satellite. IUE spectra have been corrected for interstellar extinction adopting A(V)=0.32.

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3. Computational method

The photospheric model of the K2 star, with $\log g$=2.0, $T_{\rm eff}$=4400 K and [A/H]=0.0, has been computed using the ATLAS9 code (Kurucz 1993). Models for the lower transition region have been derived following the method applied in Lanzafame et al. (2000). Chromospheric models were built by interpolations between the photospheric and the transition region models. Using as free parameters the minimum of temperature, the pressure and the turbulent velocity at the base of the transition-region, a grid of 227 models have been constructed. The coupled equations of radiative transfer and statistical equilibrium were solved for the H, Na and Mg atomic models using the version 2.2 of the code MULTI (Carlsson 1986). Line blanketing has been taken into account using the method described in Busà et al. (2001). The latter paper also describes the atomic models for H and Na adopted here, the atomic model for Mg is described in Lanzafame et al. (2000).

4. Results

The selected model shown in the left panels of Fig. 1 describes the mean outer atmosphere of

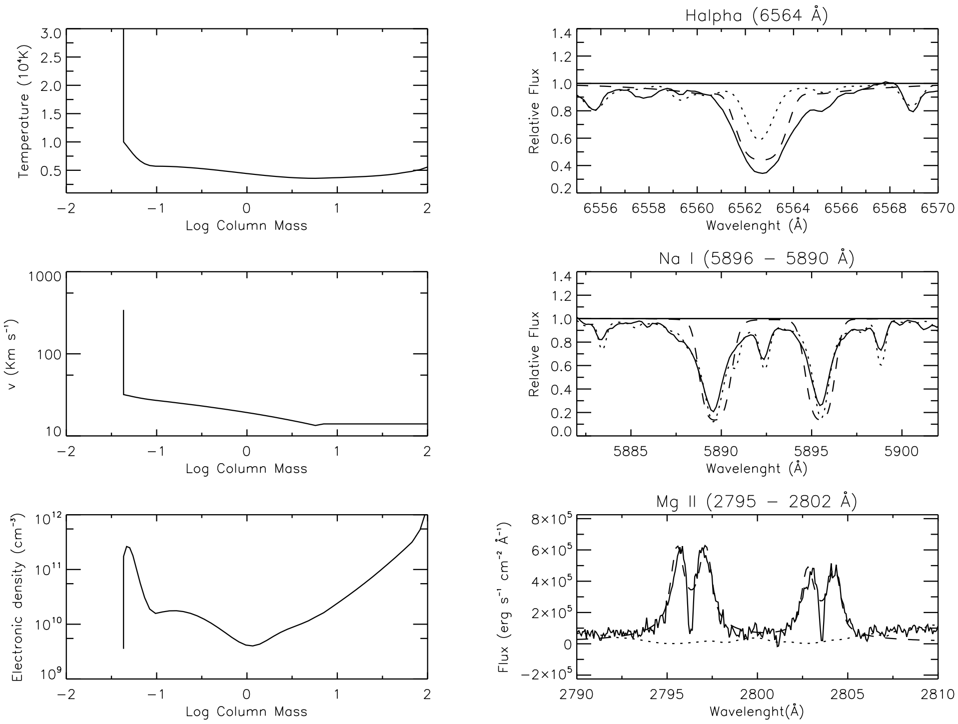

Fig. 1. [Left Panels:] Temperature, electron density, turbulent velocity of the semiempirical model that best reproduces the observations. [Right Panels:] NLTE profiles computed from the complete atmospheric model (dashed lines) and LTE photospheric computed profiles (dotted), compared with observations.

the K2 star of the system and gives informations on its mean physical properties. In particular we find the minimum of temperature close to 3600 K and a chromospheric plateau at about 6000 K. In the whole outer atmosphere and in particular in the upper chromosphere and transition region layers, the turbulent pressure strongly dominate on the gas pressure. In the right panels of Fig. 1 the synthetic lines from the selected model are compared with the observed profiles. Although the H-α computed profile shows broad wings somewhat similar to those observed, they are are not broad enough, indicating that the observed H-α extra-absorption cannot be interpreted only in terms of radiative transfer effects in the outer atmospheric model. Furthermore, the distribution of turbulent velocity of the selected model with velocities of up to 300 kms^{-1} (left middle panel), very likely, could produce evaporation from the Roche Lobe and mass loss from the cool K2 star. This result gives strength to the hypothesis of the presence of a high-turbulent inter-system cloud as described in (Marino et al. 2001).

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