CIV 1550 Transition Line Observations of AB Doradus with the Hubble Space Telescope

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1. Introduction

AB Doradus (HD 36705) is one of the most interesting active late-type stars from radio to X-rays. This is due to its proximity (15 pc), short rotation period (0.514 day), small age $10^7$ y and spectral type K0-K2 IV-V (see e.g. Cameron and Robinson, 1989, MNRAS, 238, 657; Vilhu et al. 1993, A&A, 278, 467; Rucinski et al. 1995, ApJ, 449, 900; White et al. 1995, IAU Symp. 151).

Our observations with the Hubble ST covered November 14.08 - 14.30, 1994 (UT), corresponding to rotational phases between 0.19 - 0.63. The post-COSTAR GHRS (cycle 4) was used with the grating G160M, centered at the CIV 1550 doublet. The instrumental profile was Gaussian with a FWHM 15 km/s. The spot B (at phase 0.5) was well visible in our simultaneous U-band light curve (. This spot was also active in the radio as seen in the Australia Telescope Compact Array (ATCA) observations from the following day. Especially remarkable were the many impulsive flares in CIV, the two strongest having rise times 20 and 100 sec and decay times 70 and 240 sec, respectively.

2. The Bimodal CIV 1550 Line Profiles

The accumulated quiescent profile (shown in Fig.1) is extremely well fitted with two Gaussians (at the non-rotating stellar surface), broadened with the 90 km/sec rotational and 15 km/sec instrumental profiles. The Gaussian fit parameters are (radial velocity minus 30 km/sec, FWHM, Intensity): NARROW (8 $\pm$ 1 km/sec, 68 $\pm$ 2 km/sec, 4.0 $\pm$0.2 $\times$ 10$^{-13}$ erg/sec/cm$^2$) and BROAD (2 $\pm$4 km/sec, 334 $\pm$8 km/sec, 3.8 $\pm$0.2 $\times$ 10$^{-13}$ erg/sec/cm$^2$). The 'narrow' and broad components have roughly equal fluxes in AB Dor and indicate large non-thermal velocities, both much larger than the 15 km/sec thermal velocity of CIV. The bimodal structure of the quiescent CIV line profile might be due to two separate microflaring patterns and resulting velocity fields on the stellar surface, as discussed previously by Linsky and collaborators (Linsky and Wood, 1994, ApJ, 430, 342; Linsky et al. 1995, ApJ, 442, 381; Wood et al., ApJ, 1995, in press).
3. The Broad Quiescent Component: Microflaring or Slingshot Prominences?

The two distinct TR-components can be related as foot-points to the two-temperature structure of the corona. Twisting and shaking of magnetic field lines by these two velocity fields could lead to two heating regions with resulting hot (large) and cool (small) coronal loops. Although the 2T-fittings are still in doubt, ASCA seems to confirm them. White et al. (1995) fitted the quiescent spectrum of AB Dor with two thin plasma models, $7 \times 10^6$ K and $1.7 \times 10^7$ K, with roughly equal emission measures. It is important to note that also the narrow and broad components of the CIV-line have equal emission measures.

However, there is another possible mechanism to explain the broad component (observed Gaussian FWHM = 360 km/sec) we see in the quiescent spectrum. Suppose that this component is not arising in large X-ray loop structures at all, but within the slingshot prominence complexes we see in Hα discovered by Cameron and Robinson (1989, MNRAS, 238, 657). The co-rotating slingshot prominence system is concentrated around 2.7 to 3 stellar radii from the rotational axis (where the centrifugal force equals the gravity). This gives each individual cloud a velocity half-amplitude of 270 km/sec. A large enough number of these could well mimic a Gaussian with FWHM in the required range.

The prominences could consist of a system of tube-like filaments embedded in the ambient corona. Each filament would have a cool (8000 K) and dense core (where the Hα absorption comes from), surrounded by a thin transition region where the temperature rises steeply and radially outward until it reaches the coronal value.

![Figure 1. The flaring and quiescent Hubble CIV 1550 spectra of AB Dor. The 2-Gaussian components (dotted) and the resulting fits (continuous lines) are shown.](image-url)