A statistical study of the UV Mg II resonance lines' parameters in 20 Be stars

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1. Introduction

The Mg II resonance lines have a peculiar profile in the Be stellar spectra, which indicates a multicomponent nature of their origin region. Many researchers have observed the existence of absorption components shifted to the violet or red side of the main spectral line (e.g. Doazan 1982, Danezis et al. 1991, Doazan et al. 1991, Lyratzi et al. 2003, 2007, Danezis et al. 2007). These components were named Discrete Absorption Components (DACs: Bates & Halliwell 1986) or Satellite Absorption Components (SACs: Danezis et al. 2003; Lyratzi & Danezis 2004). They probably originate in separate regions that have different rotational and radial velocities. In any case, the whole observed feature of the MgII resonance lines is not the result of a uniform atmospherical region, but it is constructed by a number of components, which are created in different regions that rotate and move radially with different velocities.

In this paper, using the GR model (Danezis et al., 2007), we analyze the UV Mg II λλ 2795.523, 2802.698 Å resonance lines in the spectra of 20 Be stars of different spectral subtypes, taken with IUE, in order to investigate the presence of Satellite Absorption Components (SACs) and Discrete Absorptions Components (DACs). From this analysis we can calculate the values of a group of physical parameters, such as the apparent rotational and radial velocities, the random velocities of the thermal motions of the ions, as well as the Full Width at Half Maximum (FWHM) and the absorbed energy and of the independent regions of matter which produce the main and the satellites components of the studied spectral lines. Finally, we present the relations between these physical parameters and the effective temperature of the studied stars.

2. Data

The data we used are the MgII resonance lines of 20 Be stars. The spectrograms of the stars have been taken with IUE satellite, with the Long Wavelength range Prime and Redundant cameras (LWP, LWR) at high resolution (0.1 to 0.3 Å).

The list of the studied stars and their spectral subtype is presented in the following Table.

Table List of the Be stars and their spectral subtype.

Star	Spectral Subtype
HD 53367	B0 IV e
HD 44458	B1 V pe
HD 58343	B2 N ne
HD 45910	B2 III e
HD 41335	B2 V ne
HD 52721	B2 V ne
HD 37202	B2 IV p
HD 32991	B2 V e
HD 58050	B2 V e
HD 37490	B3 III e
HD 25940	B3 V e
HD 183362	B3 V e
HD 217050	B4 III pe
HD 67888	B4 III pe
HD 89884	B5 III
HD 23480	B6 IV e
HD 192044	B7 V e
HD 29866	B8 IV ne
HD 199218	B8 IV nne
HD 50138	B9

3. Variation of the physical parameters of the Mg II regions, as a function of the effective temperature of the studied stars.

In Figure 1, we present the Mg II doublet of the B2 V ne star HD 52721, and its best fit. The best fit has been obtained with two SACs. The graph below the profile indicates the difference between the fit and the real spectral line. We note that in all stars the best fit has been obtained with one or two SACs.

In the following figures we see the variation of the physical parameters in the Mg II regions of 20 Be stars, as a function of the effective temperature. Specifically:

In Figures 2 - 5 we present the variation of the mean values of the rotational velocities, the radial velocities, the random velocities of the ions and the Full Width at Half Maximum (FWHM), for the Mg II independent density regions of matter, which create the 1 or 2 satellite components in each of the λλ 2795.523, 2802.698 Å Mg II resonance lines, as a function of the effective temperature.

Finally, in Figure 6 we present the variations of the absorbed energy (Ea) in eV, of the λλ 2795.523, 2802.698 Å Mg II resonance lines, for all the independent density regions of matter which create the 1 or 2 satellite components in all the stars of our sample, as a function of the effective temperature.

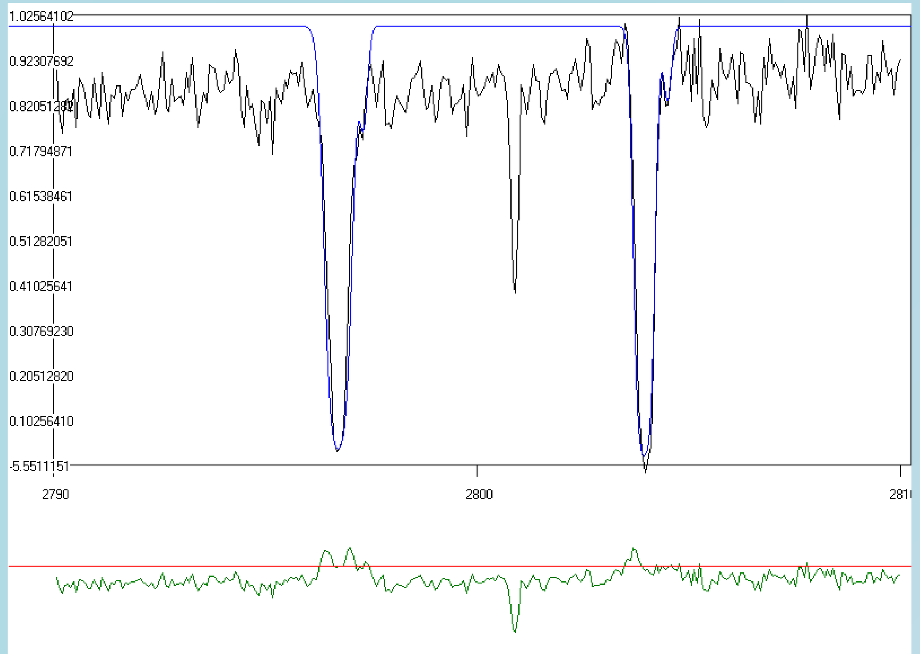

Figure 1: The Mg II λλ 2795.523, 2802.698 Å resonance lines in the spectrum of HD 52721. Each of Mg II spectral lines consists of two SACs. The graph below the profile indicates the difference between the fit and the real spectral line.

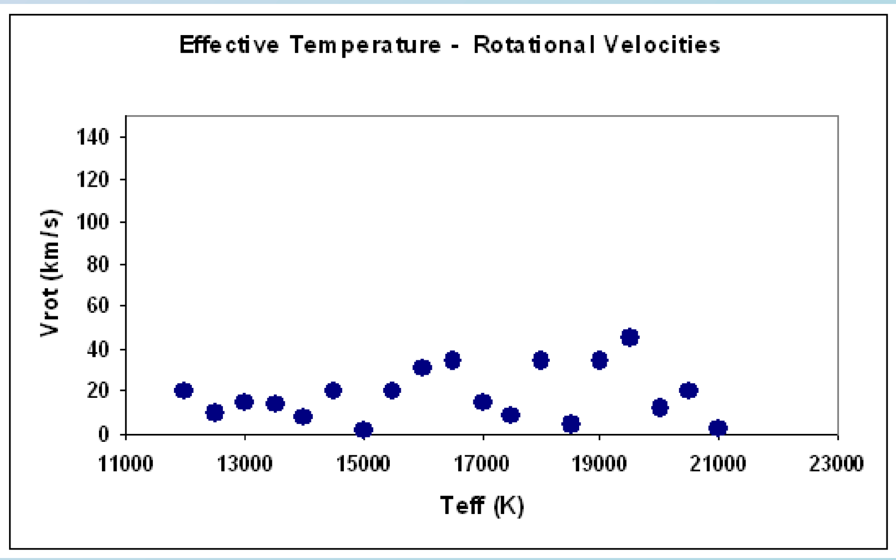

Figure 2. Variation of the rotational velocities of the Mg II resonance lines (λλ 2795.523, 2802.698 Å) for the independent density regions of matter which create the 1 or 2 SACs, as a function of the effective temperature. The values of the rotational velocities are between 5 and 40 km/s.

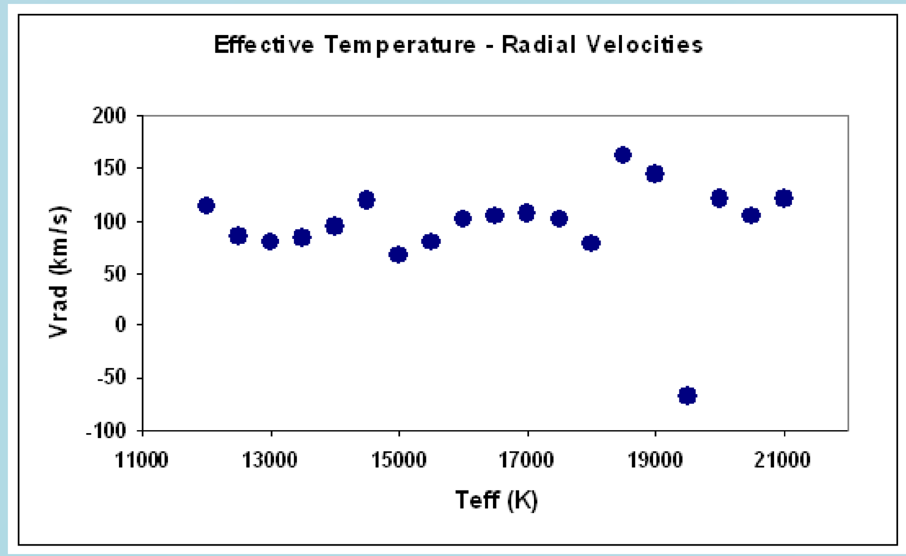

Figure 3. Variation of the radial velocities of the Mg II resonance lines (λλ 2795.523, 2802.698 Å) for the independent density regions of matter which create the 1 or 2 SACs, as a function of the effective temperature. We detected values between 50 and 150 km/s, except in the case of the star HD 45910 where we detected a Mg II density region with radial velocity of about -70 km/s. This case was checked very carefully.

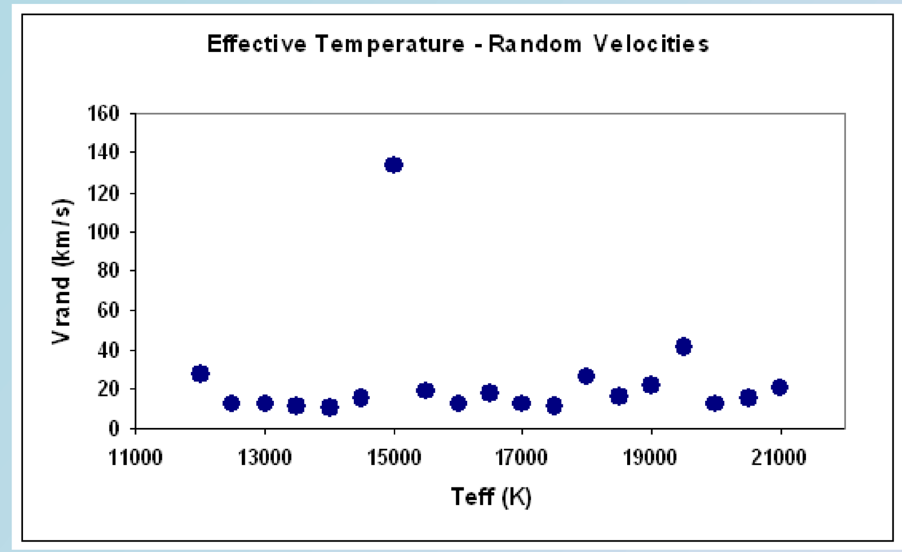

Figure 4. Variation of the random velocities of the Mg II resonance lines (λλ 2795.523, 2802.698 Å) for the independent density regions of matter which create the 1 or 2 SACs, as a function of the effective temperature. We detected values between 10 and 40 km/s, except in the case of the star HD 217050, where the calculated value of the random velocity is about 140 km/s.

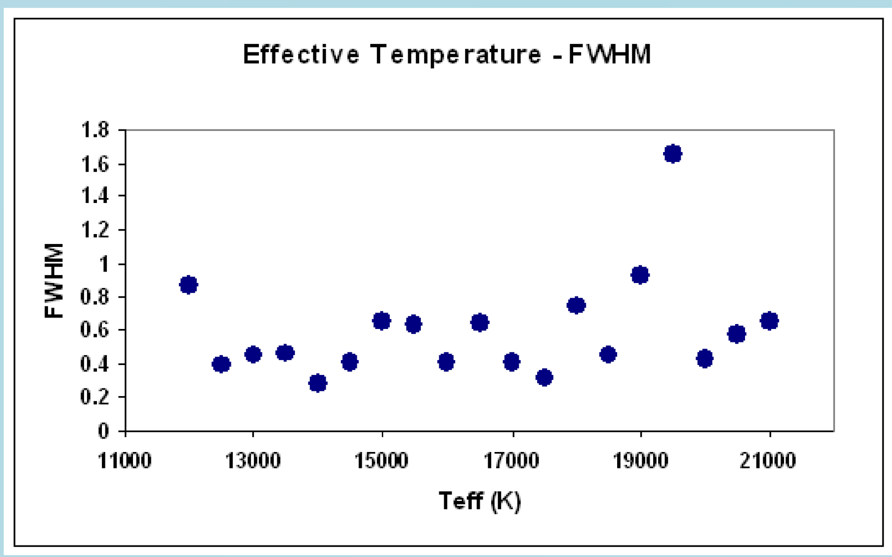

Figure 5. Variation of the Full Width at Half Maximum (FWHM) of the Mg II resonance lines (λλ 2795.523, 2802.698 Å) for the independent density regions of matter which create the 1 or 2 SACs, as a function of the effective temperature. We detected values between 0.2 and 1.6 Å.

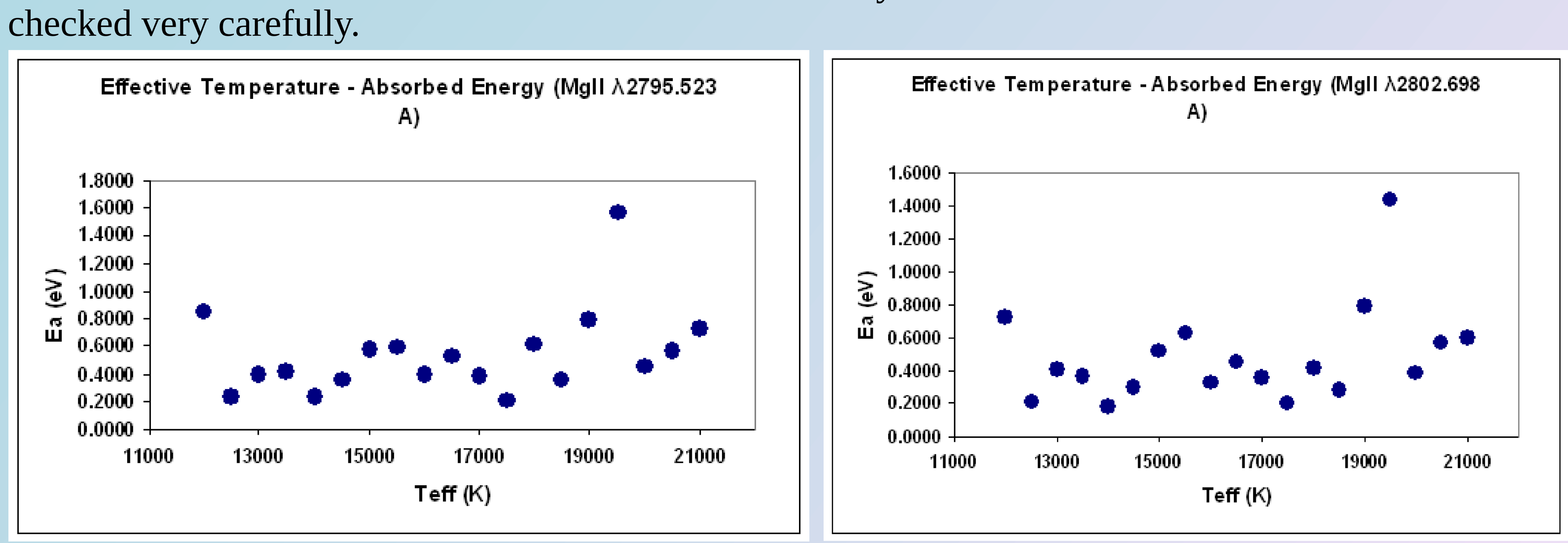

Figure 6. Variation of the absorbed energy (Ea in eV) of the Mg II resonance line λ 2795.523 Å (left) and λ 2802.698 Å (right) for the independent density regions of matter which create the 1 or 2 satellite components, as a function of the effective temperature. We note the same variation of the absorbed energy and the FWHM. (see Fig. 5).

4. Results

Rotational velocities:

The values of the rotational velocities are between 5 and 40 km/s.

Radial velocities:

We calculated values between 50 and 150 km/s, except in the case of the star HD 45910 where we detected a Mg II density region with radial velocity of about -70 km/s. This case was checked especially.

Random velocities:

The values of the random velocities are between 10 and 40 km/s, except in the case of the star HD 217050, where the calculated value of the random velocity is about 140 km/s. This means that in the case of HD 217050 the main reason of the line broadening is the thermal motions of the ions and the rotation of the layer of matter contributes less to the broadening of the spectral line. In this case we expect a low value of the respective rotational velocity. In fact, the respective rotational velocity has a value of about 2 km/s (see fig. 2).

Full Width at Half Maximum (FWHM) and Absorbed Energy:

The variation of Full Width at Half Maximum (FWHM) of the Mg II resonance lines (λλ 2795.523, 2802.698 Å) is similar as the variation of the absorbed energy.

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