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THE VERY BROAD LINES IN THE UV SPECTRA OF HOT EMISSION STARS - A POSSIBLE EXPLANATION

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Abstract. In some cases, the UV spectral lines of hot emission stars and quasars have very large widths that can not be explained as the consequence of rotational or random velocities. In this paper we present a new idea to explain this phenomenon.

1. INTRODUCTION

In the UV spectra of some hot emission stars and quasars (Andrillat & Fehrenbach 1982, Andrillat 1983, Marlborough 1969, Poeckert & Marlborough 1979, Doazan 1970, Antoniou et al. 2008) we can detect very broad absorption or emission lines that we can not explain as rotational or random velocities of the density layers that construct these lines.

In the case of emission lines, Marlborough (1969) and Poeckert & Marlborough (1979) tried to justify the large width of the Hα line wings, with their model, according to which the envelope is rotating and expanding. They showed that the photon scattering due to electrons is able to produce significant wing broadening, meaning that a large number of photons may be scattered from the center of the emission line towards the wings. Also, Doazan (1970) suggested that the rotation of the regions that create the Hα line is not able to explain the whole observed width and there should be an additional way of acceleration. This means that the observed width is due to the combination of these two movements. She concluded that since these movements affect the width of Hβ and Hγ, we should accept that such regions exist also in the surface of the star. This means that a similar phenomenon could happen in the C IV regions.

Moreover, Doazan (1970) observed that in many Be stellar spectra the rotational velocity which corresponds to the width of the Hα emission line, is larger than the velocity which is due to the stellar rotation ($V\sin i$), when $V\sin i$ is smaller than 350 km/s. She suggested that if we accept that the only reason of the emission line broadening is the rotation, then we should also accept that the emission layers rotate more quickly than the central star and that in many cases their rotational velocity is larger than the critical velocity. Finally, she proposed that the large width of the Hα, Hβ and Hγ emission lines is due to the movement of matter that lies in regions away from the central star. She concludes that since these movements affect the width of Hβ and Hγ, we should accept that such regions exist also in the surface of the star. However, the rotation of these regions is not able to explain the whole observed width and there should be an additional way of acceleration. This means that the observed width is due to the combination of these two movements.

In this paper we propose a new idea in order to explain the large absorption broadening, based on the theory of SACs phenomenon (see also Antoniou 2008).

2. DISCUSSION

In Figure 1 we present the analysis of SACs that construct the Hα line in the spectrum of HD 57815 (Lyratzi et al. 2005). We can detect very large absorption components with widths that can not be explained as random velocities (V_{rand}) of the ions or rotational velocity (V_{rot}) of the region that produces the spectral line. This means that if we consider V_{rot} or V_{rand} as main reasons of the line broadening, we calculate too large values for them, that are not physically accepted.

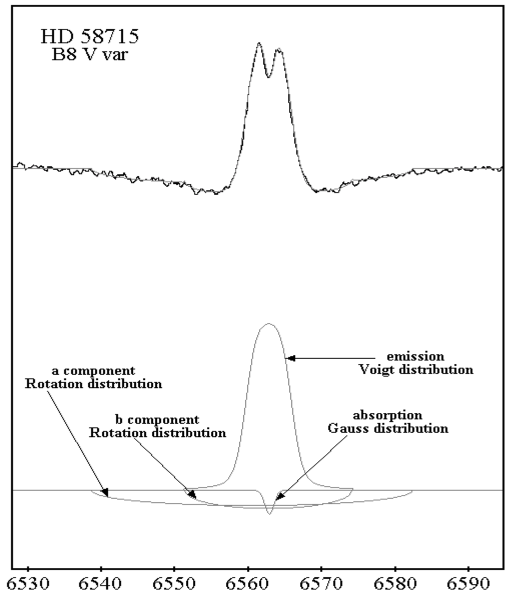

Figure 1: Very broad absorption lines of Hα in the spectrum of HD 57815. Below the fit one can see the analysis (GR model) of the observed profile to its SACs. Some of the SACs present widths which can not be interpreted as rotational or random velocities.

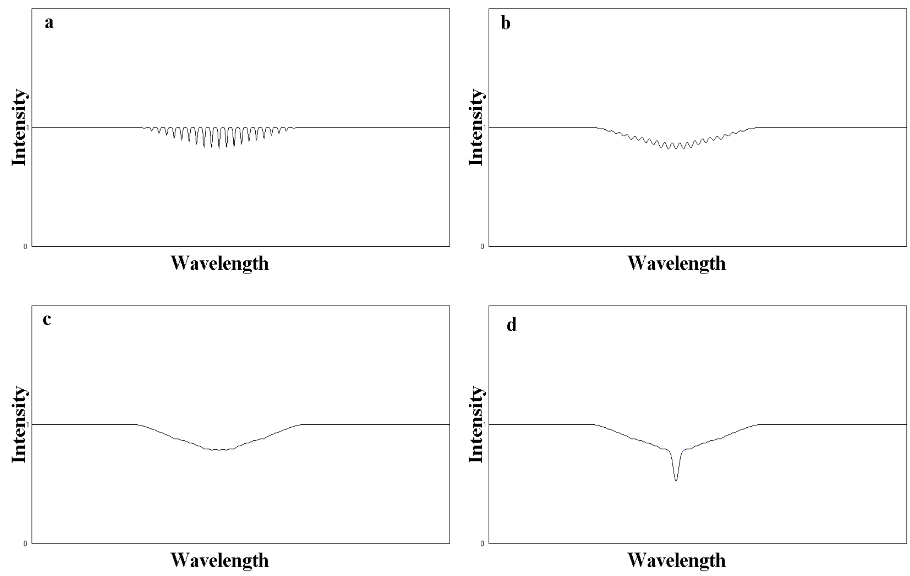

Figure 2: In (a) to (c) one can see how a sequence of lines could produce an apparent very broad absorption spectral line as an effect of SACs phenomenon. This means that when the width of each of the narrow lines is increasing (from a to c), the final observed feature looks like a single very broad absorption spectral line. In (d) one can see a combination of the apparent very broad absorption spectral line with a classical absorption line.

In Figure 2 we explain how a sequence of lines could produce an apparent very broad spectral line as an effect of SACs phenomenon.

In order to explain this very large width we propose that around a central density region that produces the main absorption lines (that may have the form of spiral streams and which have accepted values of rotational and random velocities), we can detect micro-turbulent movements, which produce narrow absorption components with different shifts. These narrow lines create a sequence of lines, on the left and on the right of the main components. The density of these lines and their widths, which are added, give us the sense of line broadening (SACs phenomenon, see Lyratzi & Danezis 2004, Danezis et al. 2007). As a result, what we measure as very broad absorption line, is the composition of the narrow absorption lines that are created by micro-turbulent effects. If this hypothesis is correct, the calculated width gives only the maximum value of the radial velocities of these very narrow components. Their appearance depends on the inclination of the rotational axis of the stellar disk.

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