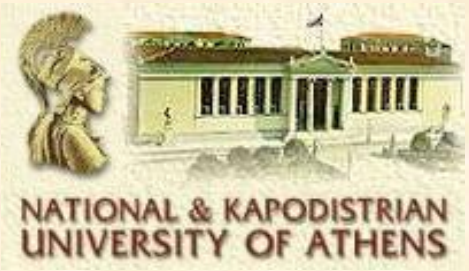


From Quasars to Stars

A method of multicomponent analysis of spectral lines of BALQSOs and Hot Emission Stars

E. Lyratzi[1,2], D. Stathopoulos[1,2], E. Danezis[1], A. Antoniou[1], D.Tzimeas[1]

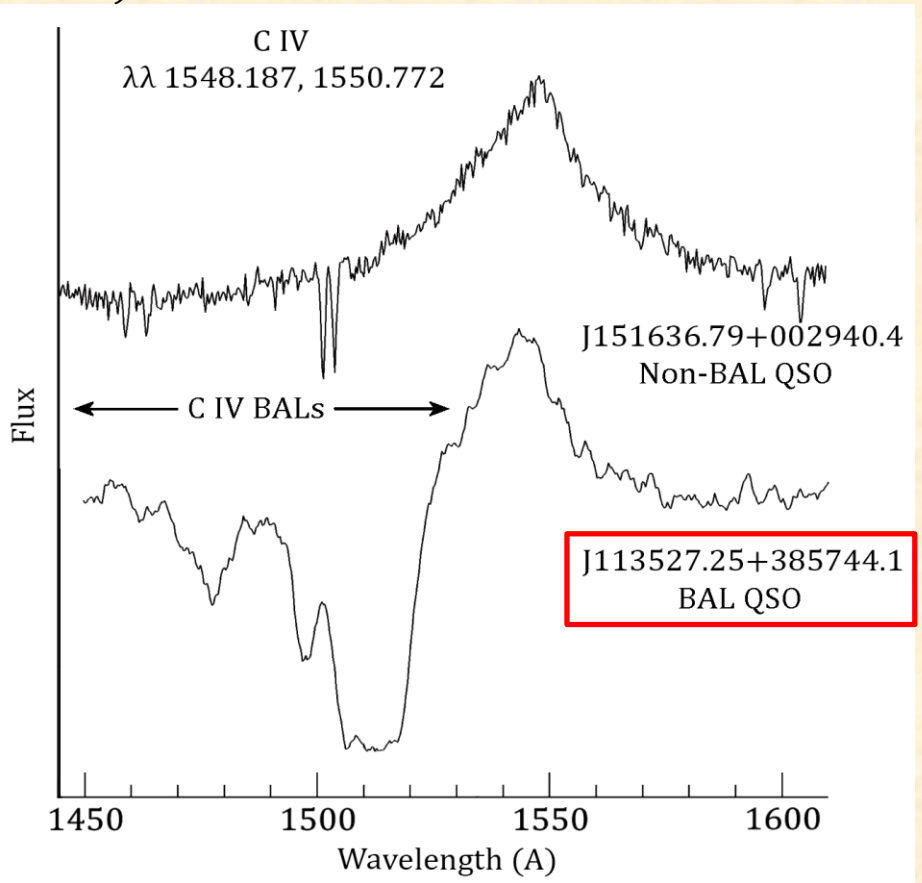
[1]University of Athens, Faculty of Physics Department of Astrophysics, Astronomy and Mechanics, Panepistimioupoli, Zographou 157 84, Athens, Greece
[2]Eugenides Foundation, 387 Syngrou Av., 17564, Athens, Greece
e-mail: elyratzi@phys.uoa.gr, dstatho@phys.uoa.gr, edanezis@phys.uoa.gr, ananton@phys.uoa.gr, dtzimeas@phys.uoa.gr

BAL Quasars and Hot Emission Stars
Similar phenomena

In the spectra of **BAL Quasars (BALQSOs)** and **Hot Emission Stars (Be and Oe Stars)** we can detect similar phenomena. This means that they may be studied and analyzed in the same way, taking into consideration the different scale.

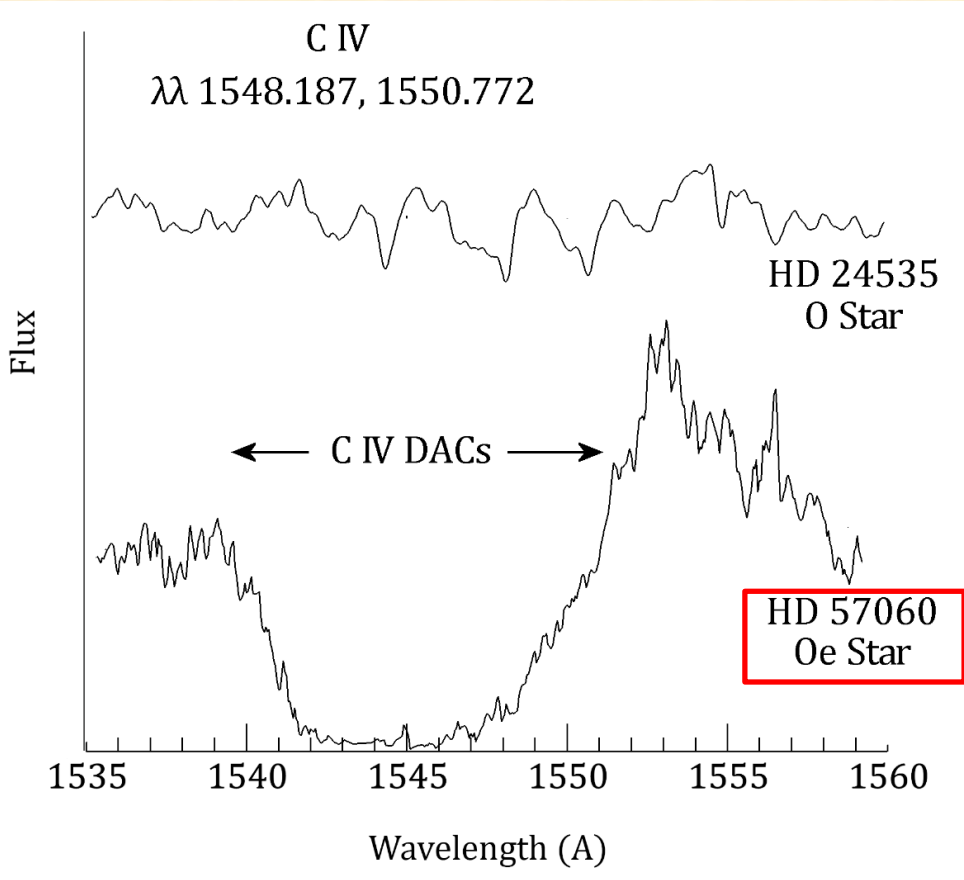
BAL QSOs

Broad Absorption Lines (BALs) are deep, broad and high velocity absorption lines blueshifted with respect to the corresponding emission lines (Hewett and Foltz 2003; Reichard et al. 2003; Foltz et al. 1990).



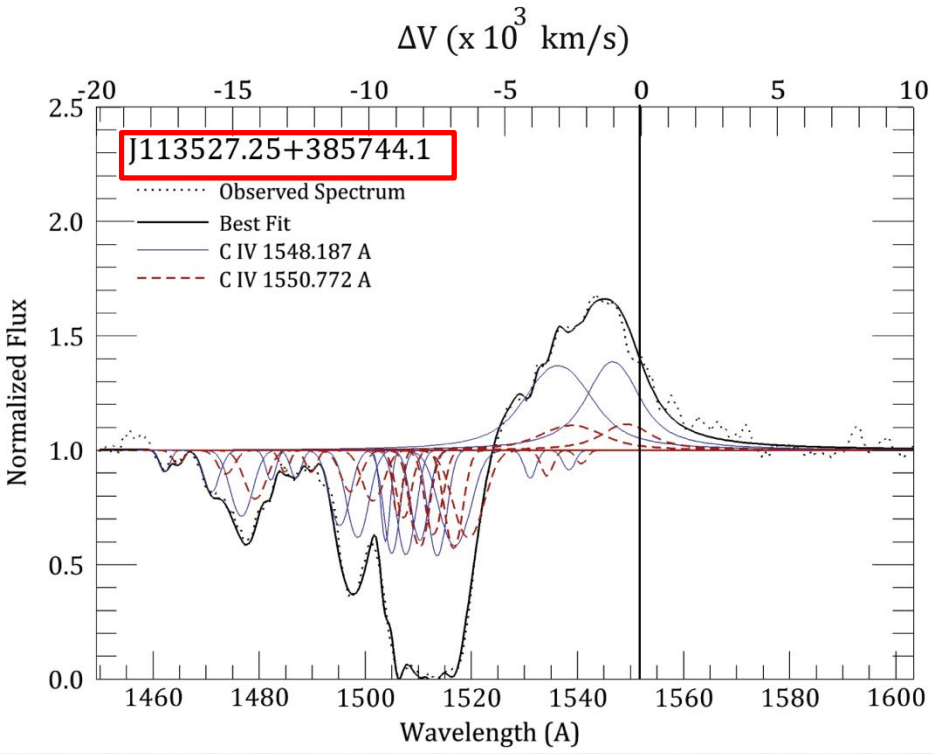
Hot Emission Stars

Discrete Absorption Components (DACs) are blueshifted strong broad absorption line components, similar (but in a smaller scale) to the BALs (Bates & Halliwell 1986).



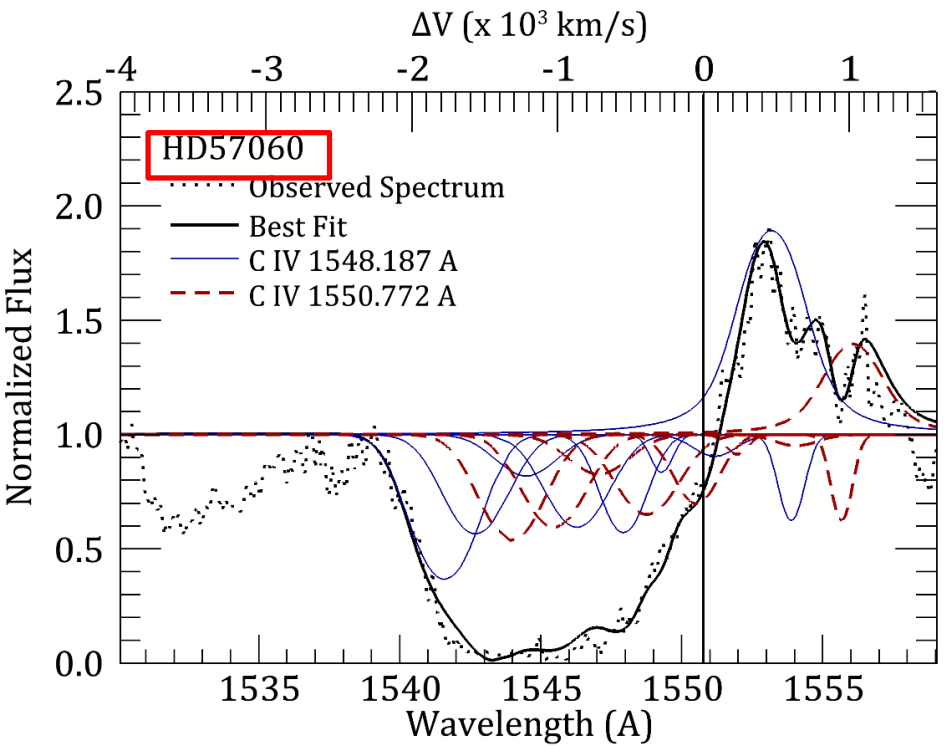
BALs in the spectra of BALQSOs and DACs in the spectra of Hot Emission Stars present many similarities

BAL QSOs
Broad Absorption Lines (BALs)



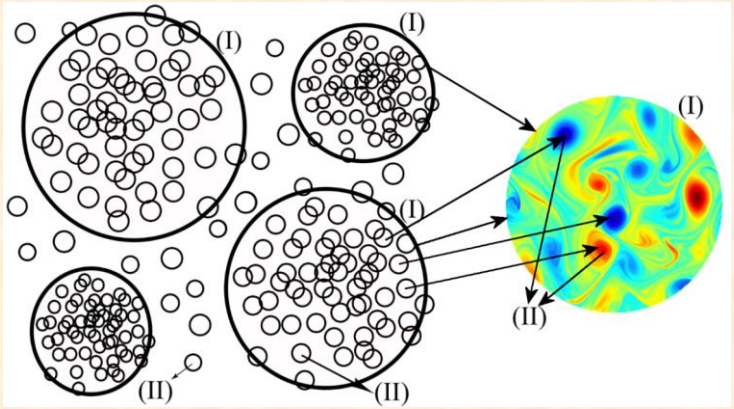
BALs are probably due to a flow of many individual clouds. According to that point of view, **the broad and complex profiles can be interpreted as the synthesis of a series of absorption components.**

Hot Emission Stars
Discrete Absorption Components (DACs)



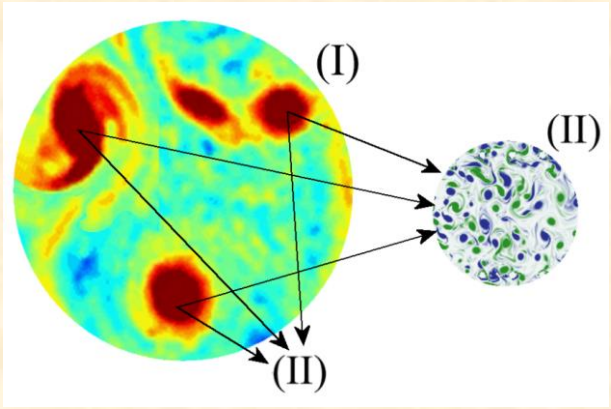
The components of DACs are created in independent high density regions of the turbulent flow in the stellar environment. The components of DACs are named **Satellite Absorption Components** (SACs) (Danezis et al. 2003, 2007; Lyratzi et al. 2007). Thus, their broadening is due to both the rotation of the density regions and the random motions of the ions therein.

Proposed physical model for BALR



- The BALR consists of independent absorption regions, called clouds (I) (McKee & Tarter 1975; Turnshek 1984; Bottorff & Ferland, 2001; Hamann et al. 2013; Capellupo et al. 2014).
  Clouds (I) are clusters of cloudlets (II) in turbulent flow. Cloudlets can be thought as density enhancements in a continuous medium (Bottorff & Ferland, 2001).
- The broad profiles of BALs are due to the synthesis of absorption lines that arise from the clouds.
- The absorption line of each cloud is quite broad, as it is the synthesis of the lines created from the cloudlets that form the cloud. The spectral line that corresponds to the clouds are the ones we fit.

Proposed physical model for DAC Region



- The DAC region (I) consists of independent absorption regions, called SACs regions (II) (Danezis et al. 2003, 2007; Lyratzi et al. 2007).
  The SAC regions (II) are density enhancements in turbulent flow.
- The broad profiles of DACs are due to the synthesis of SACs.
- Due to the turbulent flow, SAC regions rotate with significant velocities.
  The broad profiles of SACs are due to both the self-rotation of the SACs region and the random motion of the matter in these regions.
- The spectral line that corresponds to the SACs are the ones we fit.

Method

In order to study the BALs and the DACs we use the GR model (Danezis et al. 2003, 2007, Lyratzi 2007), which is a physical model with a mathematical expression that applies for both quasars' and stellar spectra.

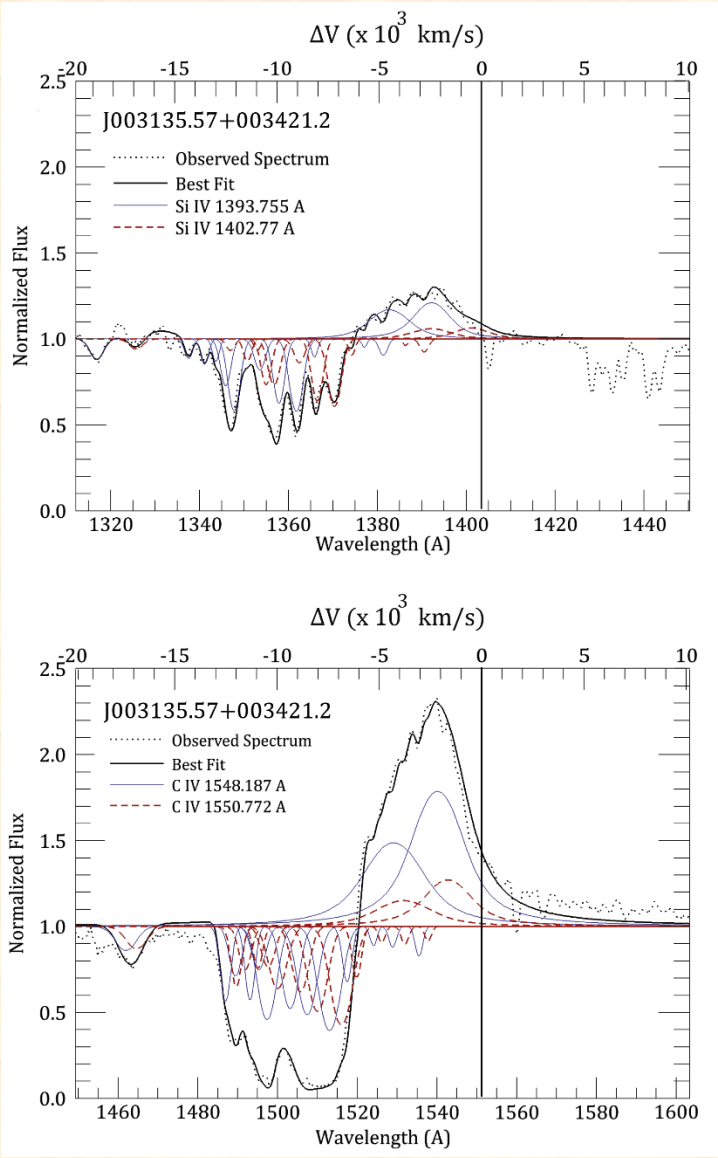
$$I_\lambda = \left[I_{\lambda_0} \prod_i \exp\{-L_i \xi_i\} + \sum_j S_{\lambda_{ej}} \left(1 - \exp\{-L_{ej} \xi_{ej}\}\right) \right] \prod_g \exp\{-L_g \xi_g\} \quad (1)$$

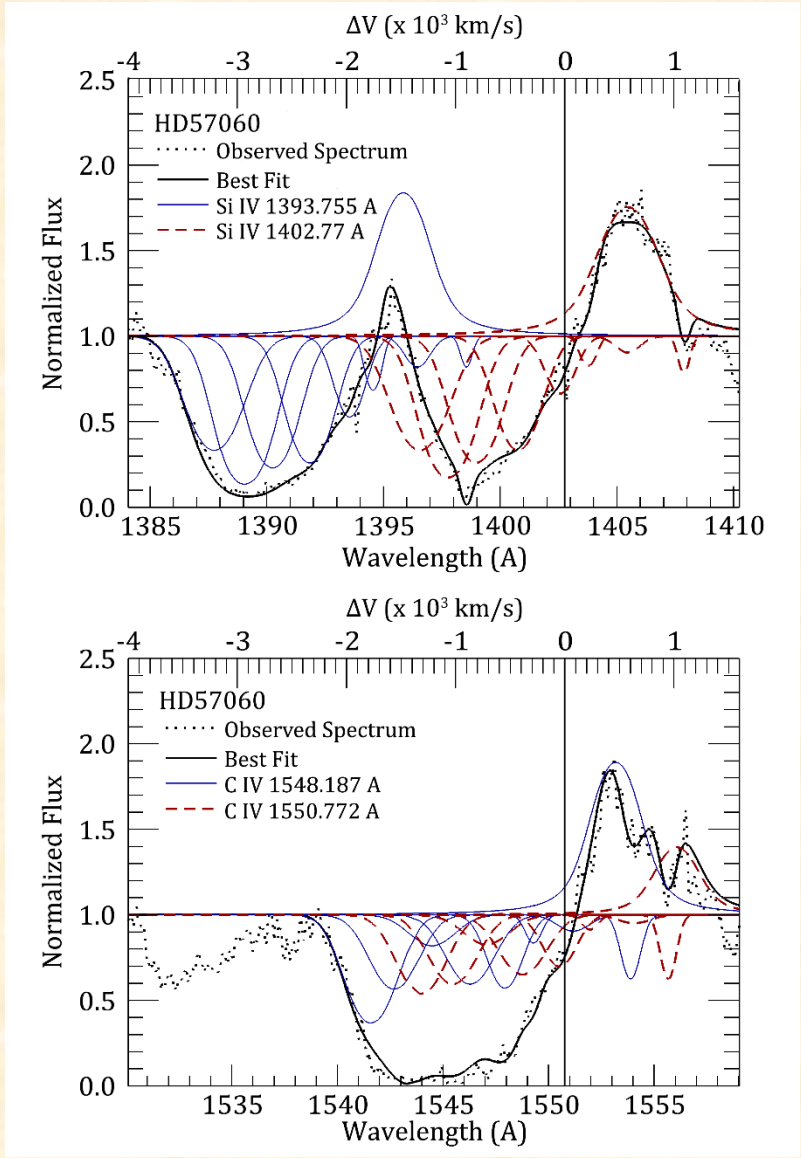
Absorption Components from clouds

Emission Components from clouds

Absorption Components from clouds

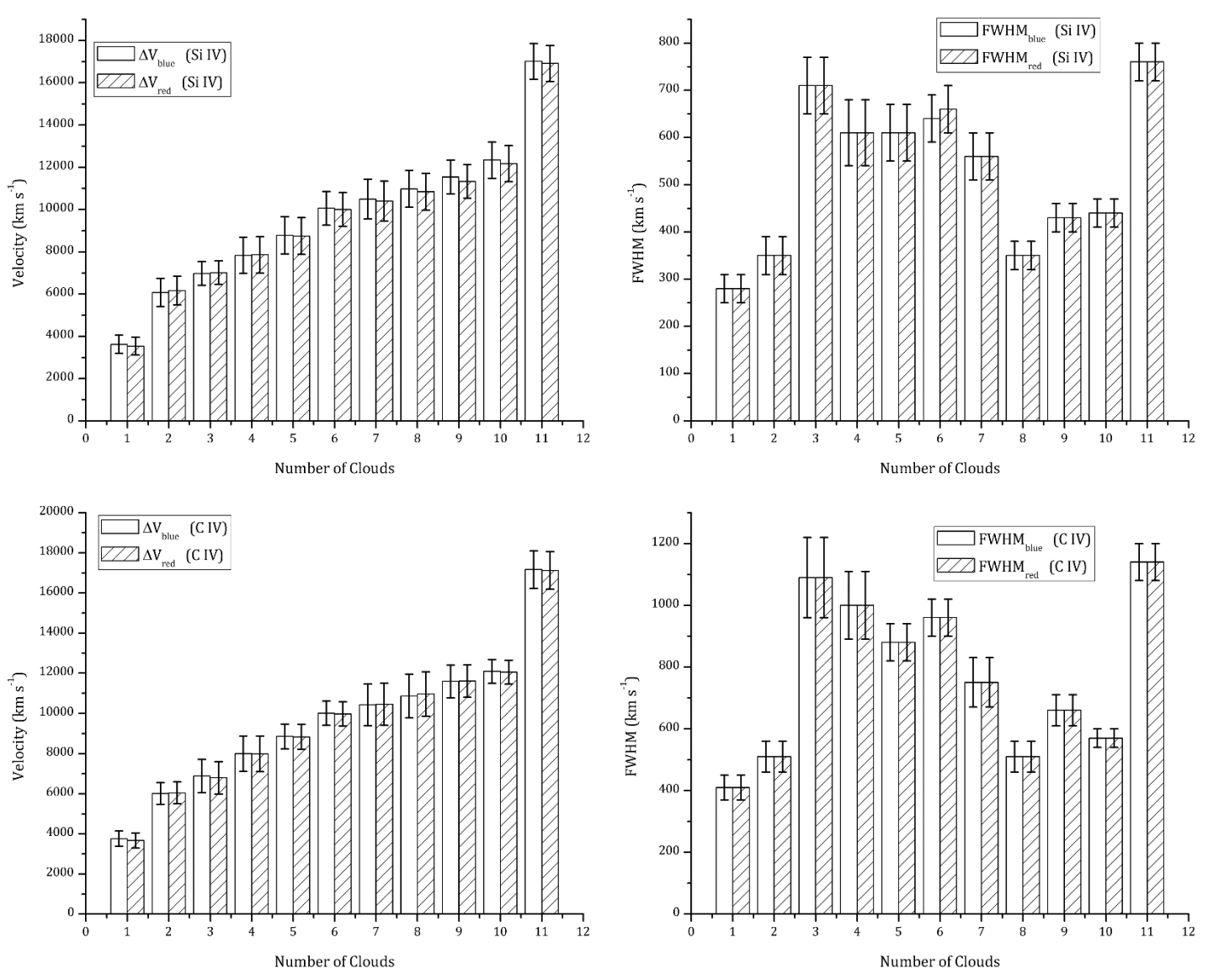
Though most BAL and DAC studies deal with the whole absorption trough, **it is very important to study each one of the components that create each BAL and each DAC**. Such a study is accomplished with the **GR model**, which also **ensures the uniqueness of the number of components and calculates the values of many physical parameters** (FWHM, optical depth, radial velocities, the equivalent width etc).





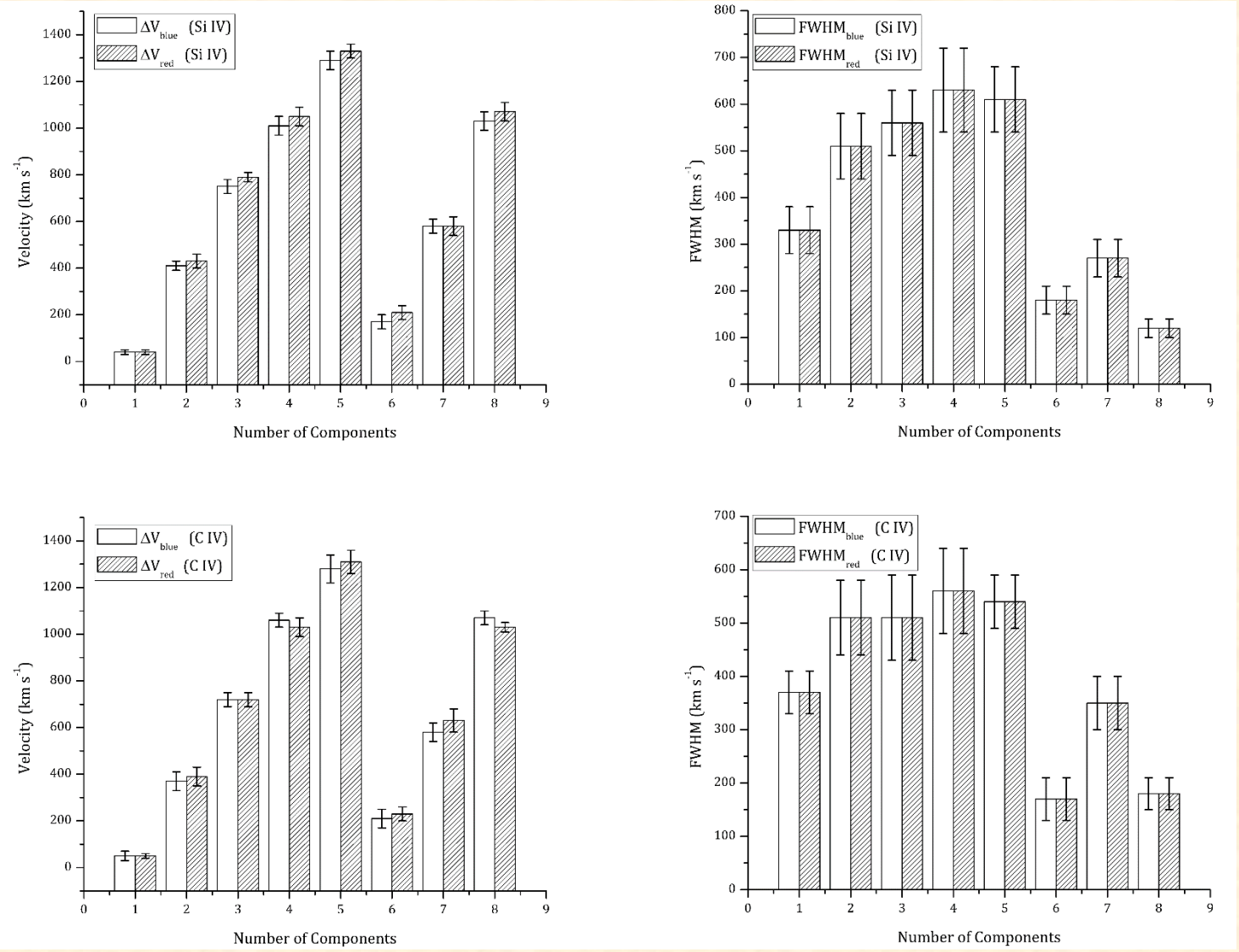
Best fit of the Si IV (top) and C IV (bottom) resonance lines in the spectrum of the BAL QSO J003135.57+003421.2 (left) and of the Oe star HD57060 (right). Both Si IV and C IV BALs are perfectly fitted with GR model. The analysis of the complex Si IV and C IV profiles is presented.

BAL QSO J003135.57+003421.2



The velocity offset and the width of the blue and the red component are exactly the same in the case of Si IV and C IV resonance lines.

Oe star HD57060



The velocity offset and the width of the blue and the red component are exactly the same in the case of Si IV and C IV resonance lines.

Thank you