INTRODUCTION

The presence of an important extra line-broadening (in addition to the rotational broadening, and usually called macroturbulence) affecting the spectra of O and B Supergiants (Sgs) has been confirmed by several authors since the first studies of linewidth measurements for early-type stars by [1]. It was initially suggested by the deficit of narrow lined objects among these type of stars ([1, 2]). Later on, the advent of high-quality spectra allowed to confirm that the rotational broadening was not enough to fit the line-profiles in some objects, and to investigate the possibility to disentangle both broadening contributions. [3] applied a goodness-of-fit method to a sample of high quality spectra of B-Sgs, and obtained acceptable results for a model in which the macroturbulence dominates and rotation is negligible. However, the reliability of this method to provide actual values for the rotational and macroturbulent velocities was somewhat limited by two facts: firstly, the similarity of line-profiles broadened by different pairs ($v \sin i$, $v_{\text{macro}}$) in the $\lambda$-space, in addition, results depend on the type of broadening profile considered for the macroturbulence (e.g. gaussian, radial-tangential; see [4]). [5], following the ideas proposed by [6], applied the Fourier transform method to a sample of OB-type stars. The strength of this method is based on the possibility to separate, independently of any other broadening mechanism, the $v \sin i$ of the star from the FT of a line profile. Their study definitely showed that, while the effect of the macroturbulence in OB dwarfs is usually negligible when compared to the rotational broadening, the effect of this extra-broadening is clearly present in early type Sgs.

Despite it was named macroturbulence at some point, the interpretation of this extra-broadening as the effect of turbulent motions is quite improbable. The effect is present in photospheric lines and affects the whole profile, even the wavelengths close to the continuum. Therefore, whatever is producing the extra-broadening has to be deeply rooted in the stellar photosphere (and maybe below), in layers in which we do not expect any significant velocity field in these stars. However, if interpreted as turbulent motions, macroturbulence represents highly supersonic velocities in most of the cases ([4], [7], [8]). This interpretation seems incompatible with the previous statement.

So far, the only (very recent) physical explanation for the appearance of macroturbulence relates to oscillations. [7] studied a sample of periodically variable B-Sgs and suggested, from the location of the stars in the $(T_{\text{eff}}, \log g)$-diagram, that this variability is due to gravity-mode oscillations. Most of their studied stars show photometric variability with main periods between 1 and 3 days, with a few stars having shorter (up to 2.5h) or larger periods (up to 25 days). Recently, [9] computed time series of line-profiles for evolved massive stars broadened by rotation and thousands of low-amplitude non-radial gravity-mode oscillations and showed that the resulting profiles could mimic the observed ones. They conclude that macroturbulence is likely a signature of the collective effect of several pulsation modes. This is a plausible explanation, but so far no direct evidence confirming its validity has been presented.
We recently started an observational project aimed at investigating the possible time-scales of variability associated to the macroturbulent broadening. Our observational strategy consists of the study of a well selected group of O and B stars (including main sequence stars and supergiants), for which we obtain time series of high-resolution, high signal-to-noise spectra.

**Preliminary Results from the First Observational Dataset**

In November 2008, we obtained a first set of spectra with the FIES cross dispersed high-resolution echelle spectrograph attached to the NOT2.5 m telescope at El Roque de los Muchachos observatory on La Palma (Islas Canarias, Spain). We used FIES in the medium resolution mode (R=46000, \( \delta \lambda = 0.03 \ \text{Å/pix} \)). The entire spectral range 3700–7300 Å was covered without gaps in a single fixed setting. We obtained time series of spectra for six early B-type Sgs during the four awarded nights. The sample was completed with two OB main sequence stars (MS) stars where macroturbulence is negligible with respect to rotational broadening. Here, we present results on the three brightest Sgs and the two MS stars (see Table 1).

| Star   | SpT & LC | \( v \sin i \) - FT | \( v \sin i \) - FWHM |
|--------|----------|---------------------|---------------------|
| HD 37128 | B0 Ia    | 45                  | 85                  |
| HD 38771 | B0.5 Ia  | 55                  | 95                  |
| HD 2905  | BC0.7 Ia | 48                  | 88                  |
| HD 214680| O9 V     | 20                  | 37                  |
| HD 37042 | B0.5 V   | 32                  | 34                  |

**Line profile variability**

We found line-profile variability (LPV) signatures in all the studied Sgs, but not in the MS stars. Indications of this variability are shown in Figure 1, where results for the first velocity moment of the SiIII 4567 line are presented (see [11], for a definition of the velocity moments of a line-profile). We also analysed other lines to investigate the effects on different line profiles (e.g. CII 4267, OII 4661, OIII 5592, and SiIII 4552, among others). Similar results were found for the various considered lines.

**Frequency analysis**

We searched for intrinsic frequencies by applying two line-diagnostics: the pixel-to-pixel variations across the line profile (IPS method [10]), and the moment variations ([11]). For the analysis of the moment variations, we use SCARGLE ([12]) and the least-squares power spectrum method ([13]). We present here only the preliminary results from the first velocity moment variations (RV).

The RV variations suggest that the B-Sgs show variabilities on two time-scales: a variation of the order of half a day to several days (Table 2), with amplitudes of the order of 1-9 km/s (also detected from the IPS analysis), and a faster variation of tens of minutes at low amplitude (see Fig. 3). However, only the longer period is found significant in the current datasets (4 S/N criterion; [14], [15], see Fig. 2). Although this period is clearly present in the LPV of all line profiles investigated, its value cannot be accurately determined given the poor frequency resolution (of the order of 0.02 c/d at best) and the influence of a bad spectral window (see top panel Fig. 2). Also, we need more data to investigate the reality of the short-term variations. A first comparison of the dispersion in RV between B-Sgs and MS stars suggests that the short periods might be intrinsic to the B-Sgs, and not caused by instrumental effects (see Figs. 1 and 3).

**Summary and Future Work**

Our preliminary analysis of line-profile variations in B-Sgs from the first FIES@NOT campaign already points to the presence of small-scale periodic variations which are not detected in the MS stars. RVs variations show variabilities of the order of half a day to several days,
with amplitudes of the order of 1-9 km/s. Similar results are obtained from lines of different ions/elements. The frequency analysis also seems to indicate short-term variations with lower amplitudes. More observations (already planned) are needed to confirm and improve these results. From the new data we expect to be able to constrain the effect of macroturbulence and to test its interpretation in terms of stellar pulsations.

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TABLE 2. Highest amplitude frequencies resulting from the frequency analysis for the B-Sgs. Total number of spectra (N) and the timespan (ΔT) of the observations are also indicated. Note: (*) or one of its aliases.

| Star   | N  | ΔT (d) | Dominant frequency (c/d) |
|--------|----|--------|--------------------------|
| HD 37128 | 60 | 3.02   | 1.50±1                   |
| HD 38771 | 48 | 2.99   | 0.30±1                   |
| HD 2905  | 30 | 3.08   | 0.58±1                   |

FIGURE 3. RV curves from the SiIII 4567 line folded according to the highest amplitude period (see Table 2). Similarly to Fig. 1, horizontal lines show the dispersion in RV found for MS stars. A short-term variability is suspected.