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# Evidence for line-profile variability in the spectrum of the O supergiant HD 152249: preliminary results.

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## Abstract

Already suspected to be variable, the O9Ib((f)) supergiant HD 152249 has been the subject of a dedicated follow-up spectroscopic run. We report here on the preliminary results. This star is definitely exhibiting significant line-profile variations which are most probably a sign of the existence of non-radial pulsations. HD 152249 could thus belong to the newly identified group of pulsating OB supergiants.

Individual Objects: HD 152249

## Introduction

As part of our extensive study of very massive stars and of very young open clusters, we acquired series of spectra in order to systematically classify O stars and to search for signs of binarity and/or variability among these stars.

As part of the survey of NGC 6231, we detected a few presumably single stars displaying variations suggesting an intrinsic origin (see e.g. Sana et al. 2008 and references therein). Some of these stars, our best candidates, were reobserved during a dedicated campaign. This is particularly the case for the supergiant star HD 152249 (see also Sana & Gosset, 2009). We report here on preliminary results of four consecutive nights of spectroscopic observations.

## Observations and physical parameters

The star HD 152249 was one of the main targets of the four-day run that took place in June 2006. The telescope used was the ESO/MPG 2.2m telescope at La Silla equipped with the high-resolution FEROS spectrograph (resolving power 48000). Several spectra ($\sim$10) were acquired each night with a S/N ratio of 250-300. The data were reduced in a classical way using the MIDAS software as well as our own codes. The spectra were processed using an improved version of the FEROS pipeline, and were then normalized to the observed continuum. The best spectra were selected and an average spectrum was elaborated.

From the measurements of the equivalent widths of the He I $\lambda$4471 and He II $\lambda$4542 lines, we confirm the O9 spectral type. From the general appearance of the spectrum and from the ratio of the Si IV $\lambda$4089 and of the He I $\lambda$4144 lines, we favour a luminosity class I. This is further confirmed by the measurements of the He I $\lambda$4388 and He II $\lambda$4686 lines. An emission in the N III $\lambda\lambda$4634-4641 lines implies an O9Ib((f)) type. Assuming an effective temperature of 30000 K (from the spectral type), we fitted synthetic spectra generated with the model atmosphere code TLUSTY (e.g. Hubeny & Lanz 1995) to the H$\gamma$ line profile in order to determine the $\log g$. We obtain a value around 3.0 whereas a similar fit to the He II$\lambda$4200 line rather points out 3.2, further supporting the supergiant classification. This conclusion is again further supported by the presence of a marked P Cygni profile with strong emission for the doublet Si IV$\lambda\lambda$1394-1403 (see Fig. 4 of Walborn & Panek 1985). These are preliminary results; other models should be utilized because we found out that TLUSTY is unable to reproduce several lines in the global spectrum. An estimation of the rotational velocity on the basis of the Helium lines yields a value $v \sin i = 60$ to 85 km s$^{-1}$. Using the method of determination via the Fourier transform (Simón-Díaz & Herrero 2007) of the profile of O III$\lambda$5592 and C IV$\lambda$5801, we arrive at a value of 55-58 km s$^{-1}$. In any case, from the various line fits and from the derived errors, we consider 110 km s$^{-1}$ as a strict upper limit.

## Line-profile variability

In order to analyze the variability of the line profiles, we divided each individual spectrum by the average one. The variability of the He I lines is illustrated in Fig. 1 by the case of $\lambda$4471. It is immediately clear that the line profile exhibits well-marked transiting features (at the ~1% level). These features travel over the line profile from blue to red: some 1.5 to 2 cycles are simultaneously visible. Along the time axis (ordinate), at a specific place in the line profile, the length of the cycle is about 0.3-0.4 days. These line-profile variations could not be due to the rotation of the star because it would necessitate either a large rotational velocity not compatible with the above derived $v \sin i$, or a very low inclination of the rotation axis that does not favour the visibility of variations due to surface inhomogeneities. The most probable hypothesis is that the line-profile variability is due to pulsations. Further detailed analyses are certainly necessary and will be conducted on all isolated lines. It could be that HD 152249 represents an extension of the pulsating B supergiant group, a new class of objects identified by Saio et al. (2006, see also Saio and Godart, 2009). In this case, this object is presently among the hottest representatives of the group. Identification of the true nature of the pulsation is awaiting further theoretical work on this particular object.

## References

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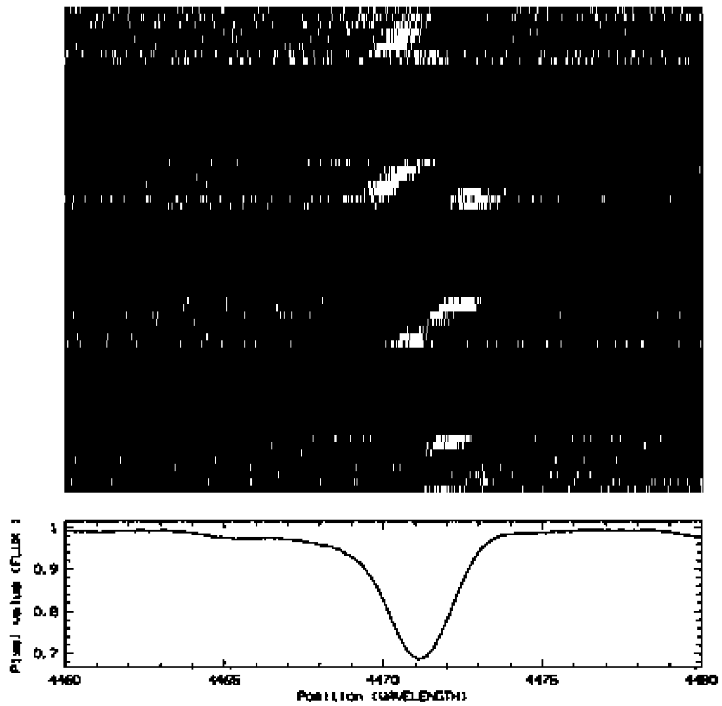


Figure 1: Variability of the He I $\lambda$4471 line in HD 152249. *Lower panel:* Spectrum as a function of wavelength; average line profile. *Upper panel:* Deviation from the average profile as a function of time. Time is linearly running from bottom to top and covers the four nights. The three internight gaps are clearly visible (uniform grey). Each horizontal line represents an individual deviation spectrum. The maximum deviations (black-white) amount to $\pm$ 1-2 %.