A combined study of spectroscopic and photometric variability in massive stars

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ABSTRACT

Massive stars are one of the most fruitful study fields in astrophysics. Despite the great effort in studying them, a lot of questions remain open. In this project, we aim to combine photometric and spectroscopic observations of OB massive stars from TESS mission and IACOB survey with the purpose of finding and understanding possible correlations between variabilities in photometry and several diagnostic lines mainly formed in the photosphere and winds of massive stars of this type.

OB STARS

Massive stars are those stellar objects with masses larger than $8M_{\odot}$. They live shorter times in the main sequence and post-main sequence states. They have special characteristics and pulsations that have been largely misunderstood due to the lack of long-term, high precision photometric data.

METHODS

Thanks to the launch of TESS, although it is not its main scientific target, we have been able to follow up the photometric evolution of a sample of massive stars with unprecedented temporal coverage. In combination with high-resolution spectroscopic observations, we have been able to propose a correlation between variations in photometry, in a diagnostic line from the winds (Hα), in diagnostic lines associated with the photosphere (exposed in the third column of Table 1).

We study the zeroth moment from the diagnostic lines from the wind with

$$\langle v^0 \rangle = \int (1 - f_n(v)) \mathrm{d}v$$

and the first moment from the photosphere [1].

$$\langle v \rangle = \frac{\int (1 - f_n(v)) v \mathrm{d}v}{\langle v^0 \rangle}$$

We have a measurement for each observation. Each star has a figure similar to Fig. 2. The variability in the moments and photometry is characterized by the standard deviation, σ.

Finally we compare the deviations for each parameter and their relation with the position in the HR diagram.

1	HD47839	O7V+B1.5/2V	O III
2	HD214680	O9V	O III
3	HD34078	O9.5V	O III
4	HD36512	O9.7V	O III
5	HD36861	O8III	O III
6	HD188001	O7.5Iabf	O III
7	HD34656	O7.5II(f)	O III
8	HD207198	O8.5II	O III
9	HD30614	O9Ia	O III
10	HD209975	O9Ib	Si III
11	HD188209	O9.5Iab	Si III
12	HD37128	B0Ia	Si III
13	HD38771	B0.5Ia	Si III
14	HD213087	B0.5Ib	Si III
15	HD2905	B1Ia	Si III
16	HD91316	B1Iab	Si III
17	HD190603	B1.5Ia+	Si III
18	HD206165	B2Ib	Si III
19	HD31327	B2.5Ib	Si III
20	HD198478	B4Ia	Si III
21	HD164353	B5I	Si III
22	HD199478	B8Ia	Si III
23	HD34085	B8Ia	Si II
24	HD21291	B9Ia	Si II
25	HD8065	B9Iab	Fe II

Table 1. From left to right: Numeration of stars from Fig. 1, their name, spectral type, and summary of the used diagnostic line for the photosphere

RESULT

We found linear relations between all the variations in Fig. 1. Moreover, the variation is correlated as expected with the evolutionary state. However, several outliers of different origins are found:

1. Possible binary systems (Fig. 2) showed in the differences in short and long period spectroscopic variation
2. Line wings sensitivity (Fig. 3)
3. Variations not well represented with the corresponding moment (Fig. 4)

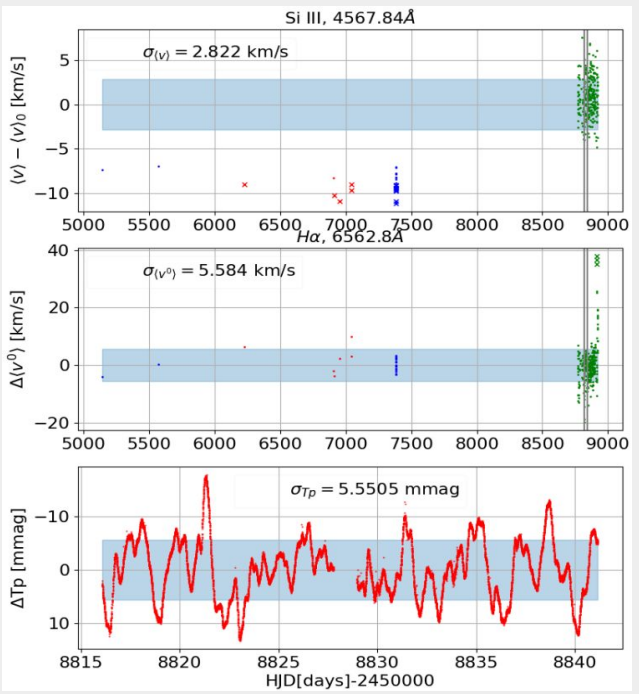

Fig. 2. From top to bottom: variability of the lines from the photosphere, winds, and photometry of HD31327.

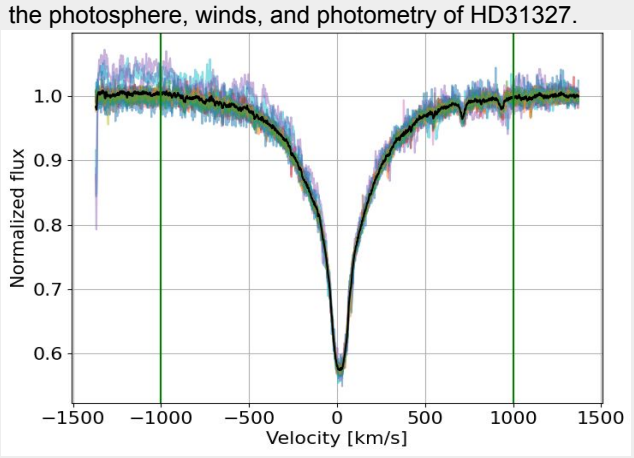

Fig. 3. Hα in different epochs for HD36512. In black, the average line.

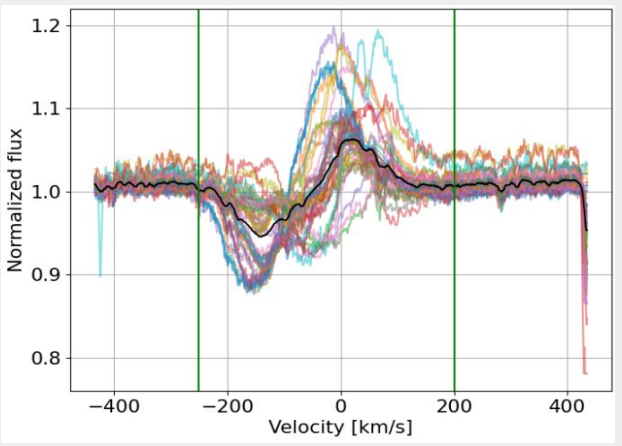

Fig. 4 Hα in different epochs for HD198478. In black, the average line.

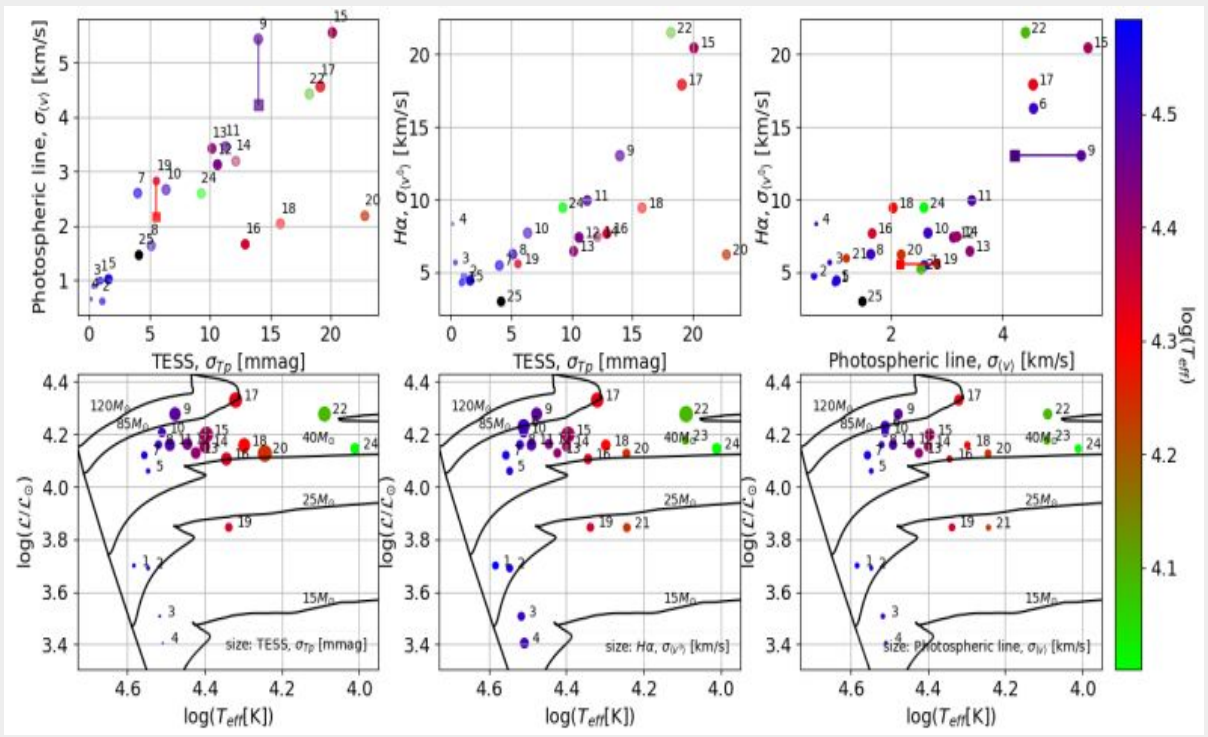

Fig 1. Top row: comparison between standard deviations of studied variations. Bottom row: Star position in the spectroscopic HR diagram; size correspond to the standard deviation; black lines are evolutionary models from [2]. Colors correspond to effective temperature.

References

[1] Aerts, M. De Pauw, & C. Waelkens. A&A, 1992.
[2] S. Ekström, C. Georgy, P. Eggenberger et al. A&A, 2012.

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