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Physics of Extreme Massive Stars
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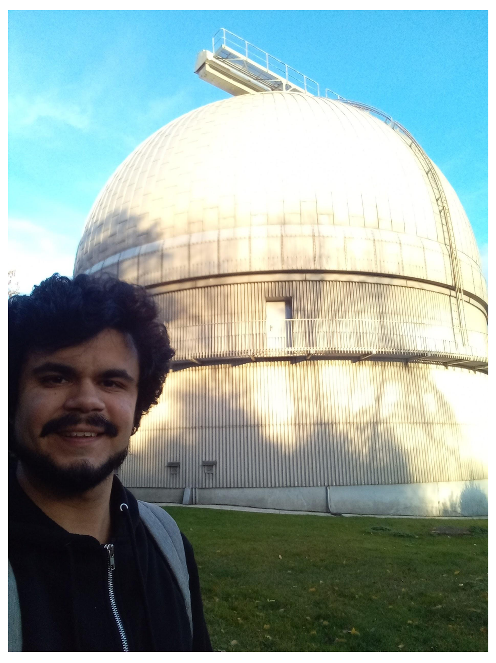
Long-term Spectral Analysis of HD 41117



Introduction:

HD 41117 is a B supergiant (BSG) with a B2 Ia spectral type, which exhibits a prominent and variable (Morel et al., 2004) Hα P Cygni profile. This is an indicator of significant stellar wind activity and justifies the presence of this star in the instability region predicted by Saio, 2011. Studies show that most of the variability could be produced by asteroseismic activity (Saio et al., 2013).

This star has been extensively studied, and while its effective temperature (Teff) and logarithm of gravity (log g) are well constrained (Teff = 18 500/19 000 K, Kudritzki et al., 1999, Haucke et al, 2018; and log g = 2.25/ 2.30 by the same authors), the estimates of their radius cover a wide range: from 23 R⊙ (Haucke et al., 2018) to 62 R⊙ (Kudritzki et al., 1999). This discrepancy is related to the uncertainty in the estimation of the distance of this star, which varies from 552 pcs (van Leeuwen, 2007) to 1615 pcs (Megier, et al., 2009).

In order to quantify the variation of Hα, we fit spectroscopic observations with the FASTWIND stellar atmosphere code (Puls et al., 2005), which allows us to estimate the wind parameters in each epoch. We also show the temporal evolution of the Q parameter (Puls et al. 1996), that connects the mass loss rate and the terminal velocity of the wind with the shape of the Hα line.

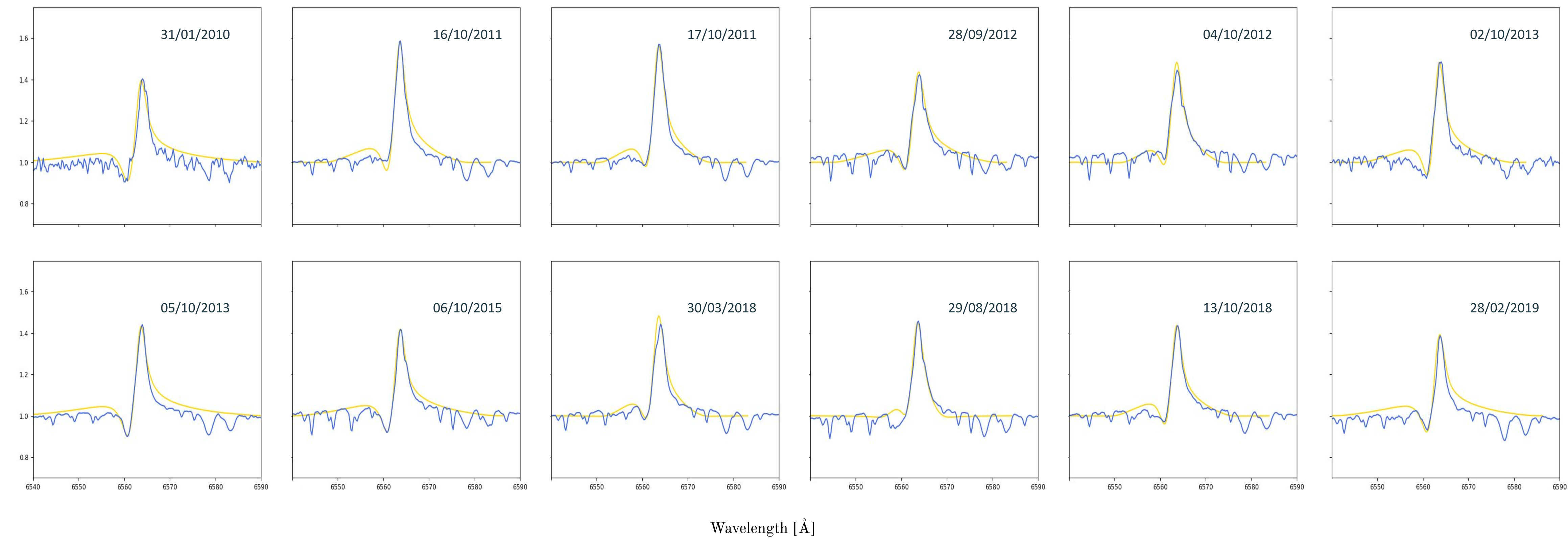


Fig. 1: Time-series of Hα emission line in HD 41 117 (in blue) compared with profiles modeled using fastwind code (in yellow).

Table 1: Wind parameters obtained for each date of HD 41117.

Date HJD	$\dot{M}$ $10^{-6} M_\odot\, yr^{-1}$	V_∞ $km\, s^{-1}$	V_{macro} $km\, s^{-1}$	$\log Q$ dex
2455228.224	0.35	1300.0	50.0	-13.169
2455850.616	0.25	700.0	40.0	-12.912
2455851.568	0.2	550.0	50.0	-12.852
2456199.494	0.25	800.0	70.0	-12.999
2456204.562	0.17	500.0	65.0	-12.861
2456567.633	0.23	750.0	40.0	-12.993
2456570.638	0.35	1250.0	40.0	-13.144
2457301.522	0.28	1000.0	50.0	-13.095
2458208.286	0.175	500.0	65.0	-12.848
2458359.624	0.11	300.0	75.0	-12.717
2458404.693	0.18	600.0	55.0	-12.955
2458543.383	0.27	1100.0	55.0	-13.173

Observations and data analysis:

The spectra used in this work cover the region around the Hα line and were obtained with the Perek 2-m telescope at the Ondřejov Observatory (Czechia from 2010 to 2019. This instrument provides a spectral resolution in the Hα region of ~ 13 000.

The aim of this work is to obtain the wind parameters in each epoch by computing the synthetic Hα line with the FASTWIND code and comparing it (by eye) with the observed one. The stellar parameters used are taken from Haucke et al. (2018): Teff = 19 000 K, log g = 2.3, R = 23 R⊙, and all profiles have β = 2 and microturbulence velocity, v micro = 10 km s-¹. To measure the change in the line profile, we chose to use the Q parameter, defined as Q = $\frac{\dot{M}}{(R_* V_\infty)^{1.5}}$. A useful property of this parameter is that Hα profiles that look similar have almost identical values of Q (Puls et al., 1996).

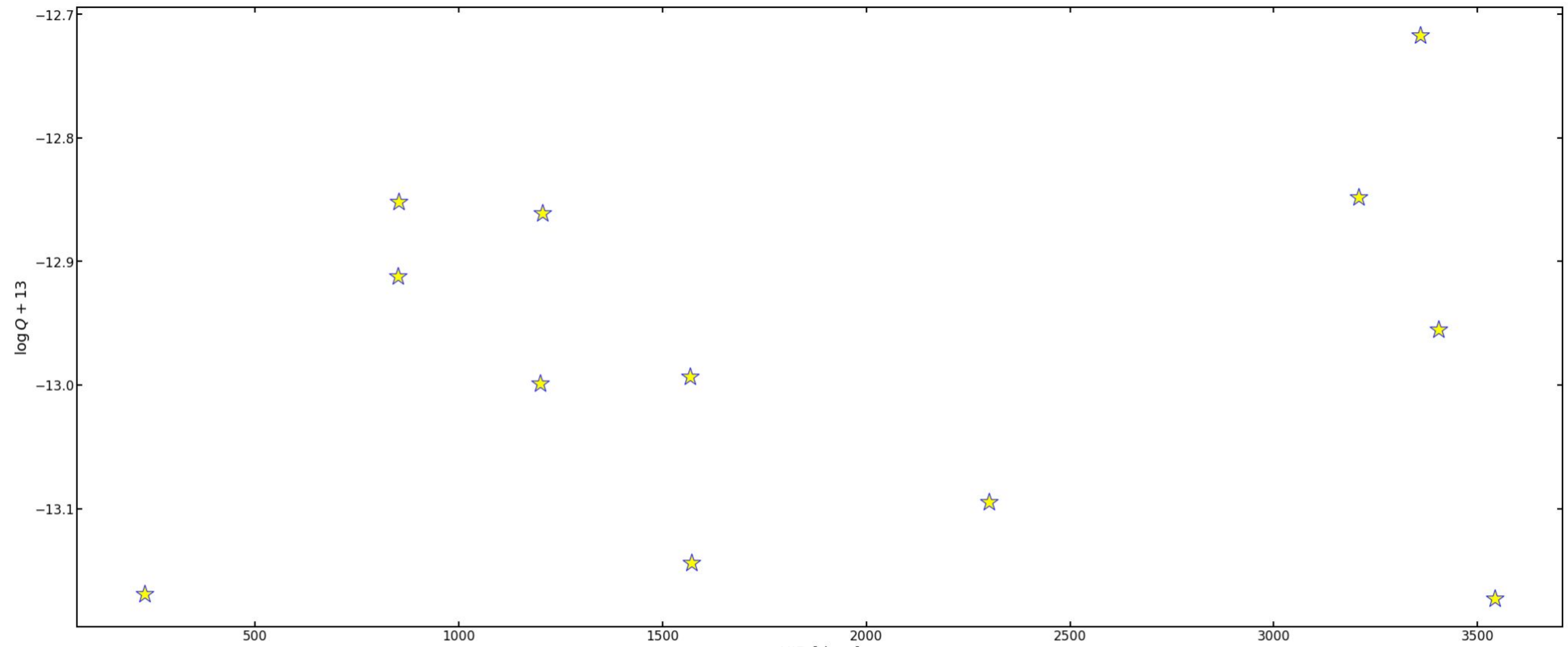


Fig. 2: Variation over time of the Q parameter of the star HD 41117 (marked with stars).

Results and future work:

- We were able to fit complex Hα profiles wich allowed us to estimate wind parameters for a set of observations that span along 10 years.

- We also present the variation the Q parameter doesn't seems to show a periodicity, this can be related to not periodic pulsations or with very shot periods.

- We will fit more spectra from the same time period and add observations from the REOSC spectrograph in CASLEO, Argentina. This is an Echelle spectra which allow us to cover a wider spectral region, including for example He and Si lines, which are very sensitive to the gravity and Teff of the stars. WIth this addition we will be able to study the short term variability of the spectra and to check if the stellar parameters are varying as well.
- We will include the moment analysis (Aerts et al., 1992) to study the pulsational content of the star.
- Finally, we want to check if there us a correlation between the spectral variability and the light curve of the star.

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