Modeling of Classical Be stars belonging to the BeSOS database

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Context

Classical Be stars are variable non-supergiant B-type stars rotating fast and holding a dust-free Keplerian circumstellar disk[1]. The origin of the disk formation is believed to be related to fast rotation, non-radial pulsations, and/or binarity. To better understand the involved mechanisms, the disk phases can be studied by following the spectral line variability observed[2][3]. Therefore, in this poster, we show an example of the stellar and disk parameters determination for the Be star, HD 102776.

Data and Methodology

To study the variability of Be stars, a spectroscopic catalog called the "Be Stars Observation Survey" (BeSOS)[4] was created. BeSOS contains data of southern Be stars observed and more than 300 multi-epoch mid-resolution spectra (R $\sim$ 17.000), S/N = 100, in the visible region (4260-7300 Å)[5].

We used a grid of models called BeAtlas[6] created with the 3D Monte Carlo code HDUST[7][8] to modeling multi-epoch spectra and obtain the disk parameters.

Our grid contains $\sim$ 14,000 models covering a range of physical parameters (star and disk) representing the Be phenomenon.

To explore the parameter space and determine the models that best represent the observations, a Python code implementation of Goodman & Weare[9] affine-invariant ensemble sampler, open source EMCEE[10] was used. This code is an MCMC method based on Bayesian statistics.

Parameters	Range	Values
M [$M_\odot$]	$3.8 - 14.6$	$3.8, 4.2, 4.8, 5.5, 6.4, 7.7, 8.6, 9.6, 10.8, 12.5, 14.6$
R_e/R_p	$1.1 - 1.45$	$1.1, 1.2, 1.3, 1.4, 1.45$
Σ_0	$0.02 - 4.0$	$0.02, 0.05, 0.12, 0.28, 0.68, 1.65, 4.0$
n	$3 - 4.5$	$3.0, 3.5, 4.0, 4.5$
Cos i	$0 - 1$	$0, 0.22, 0.33, 0.44, 0.55, 0.66, 0.77, 0.88, 1.$

Table 1. Range of parameters of BeAtlas model grid.

Modeling of HD 102776

A representative star from the BeSOS database is the bright ***j Cen*** (HD102776), which has spectral type B3V. It has a double-peaked Halpha line profile that varies mainly in intensity over the years (Figure 1).

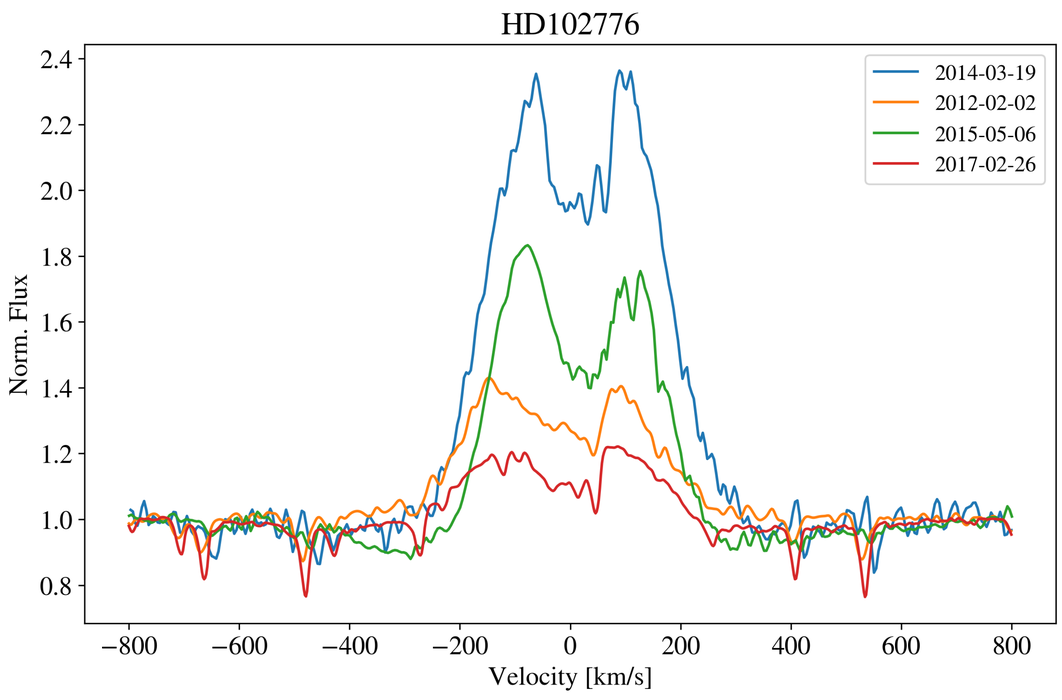

Figure 1. Variability of the double peak Halpha line profile over the years

Results

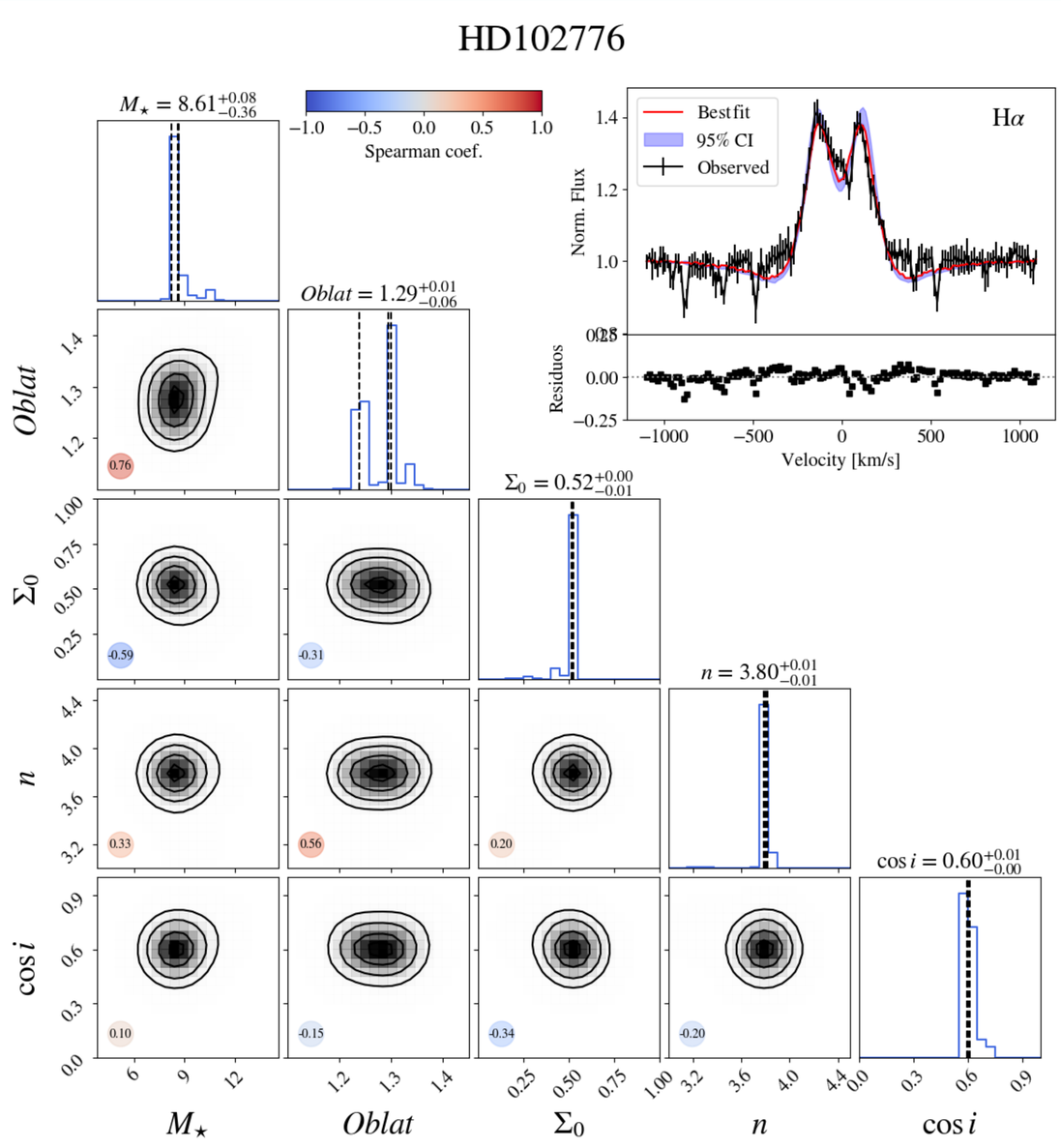

Figure 2. Corner plot of Hα line of HD102776 observed in 2012. The PDFs for each parameter are shown in the main diagonal. The coloured circles indicate the Spearman coefficient for the correlation between the pairs of parameters. On the upper inset, the observational data and residuals are plotted. The red line corresponds to the maximum likelihood and the thin cyan region corresponds to the 95% confidence interval.

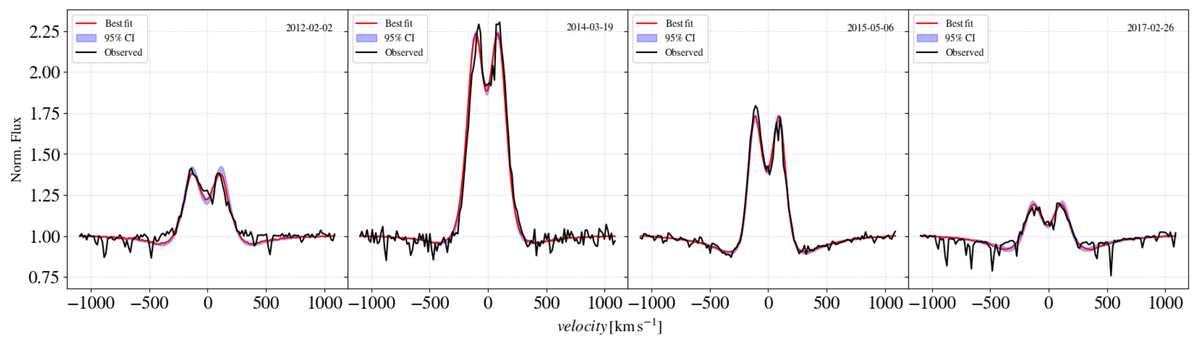

Figure 3. Adjustment of Hα line profiles for the star HD102776.

Date	M[$M_\odot$]	R_e/R_p	Σ_0	n	i°
2012/02	$8.61^{+0.08}_{-0.36}$	$1.29^{+0.01}_{-0.06}$	$0.18^{+0.01}_{-0.01}$	$3.80^{+0.01}_{-0.01}$	$53.16^{+0.20}_{-0.56}$
2014/03	$10.49^{+0.69}_{-0.55}$	$1.28^{+0.02}_{-0.07}$	$1.72^{+0.26}_{-0.55}$	$3.08^{+0.23}_{-0.05}$	$52.41^{+1.46}_{-2.18}$
2015/05	$5.41^{+0.39}_{-0.21}$	$1.13^{+0.05}_{-0.02}$	$0.11^{+0.04}_{-0.03}$	$3.46^{+0.08}_{-0.18}$	$45.45^{+1.27}_{-1.55}$
2017/02	$6.90^{+0.82}_{-0.63}$	$1.27^{+0.06}_{-0.05}$	$0.03^{+0.04}_{-0.01}$	$3.32^{+0.53}_{-0.12}$	$44.53^{+1.82}_{-2.89}$

Table 2. Physical parameters obtained for the star HD102776.

Conclusions and Future work

The continuous observation and determination of the physical parameters of Be star disks is essential for a better understanding the Be phenomenon. With these objectives, we will:

- Apply our methodology to the stars in the BeSOS survey.
- Use public optical data from other Be star surveys such as *BeSS*, as well as near-infrared (H-band) data from the APOGEE survey to model the Brackett lines formed in different regions of the disk.

KEY REFERENCES

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