Detection of a 1.59 h period in B supergiant star HD 202850

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Abstract

Photospheric lines of B-type supergiants show variability in their profile shapes. One possible cause of the line profile variability is the stellar pulsation, however B supergiants have not been systematically searched yet for the presence of especially short-term variability caused by stellar pulsations.

We obtained four time-series of high-quality optical spectra for the Galactic B supergiant HD 202850. Proper analysis using the moment method revealed a period of 1.59 hours in all three lines. Since the star seems to fall outside the currently known pulsational instability domains, the nature of the discovered oscillation remains unclear.

Aims

Detect and prove pulsational period:

- **Observe periodical change in radial velocity and connect it with pulsations**
- **Observe such change in more than one photospheric line (at least two different elements)**
- **Prove the stability of detected pulsation over time**
- **Determine the exact pulsation mode**

Methods

Moments method

Moments method quantifies characteristics of the line profile (Aerts et al. 2010). For each line profile it gives:

- **equivalent width (0 moment)**
- **radial velocity (1st moment (<v^1>))**
- **measure of width(2nd moment (<v^2>))**
- **measure of asymmetry(3rd moment (<v^3>))**

It is very useful in proving the pulsation modes. From each time series of spectra we took, we were able to calculate time series of the moments, observe change in them and draw some conclusions.

The first three moments are most important for the pulsations, while the second and other even moments suffer a lot from noise.

To recover period from time series of moments we used two methods:

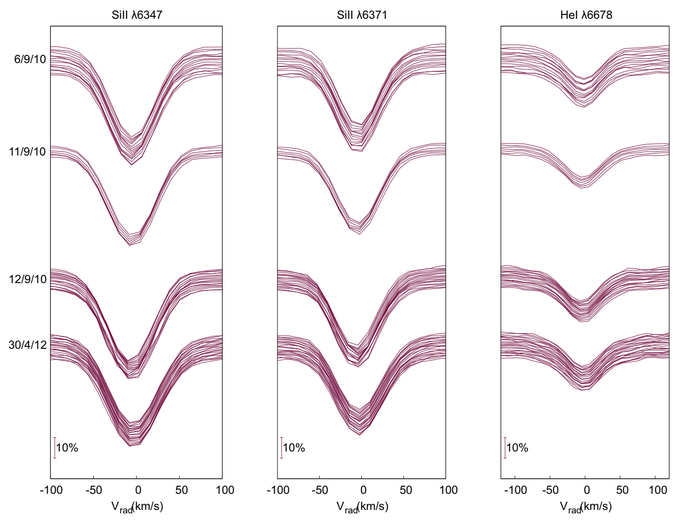
- **Fourier transformation of the time series of the moments**
- **Fitting the sine curve through the time series of the moments**

HD 202850

- **B supergiant of spectral class B9 lab**
- **Belongs to Cyg OB 4 association**
- **Silicon rich star**
- **Doesn't belong to any known instability domains.**

Observations

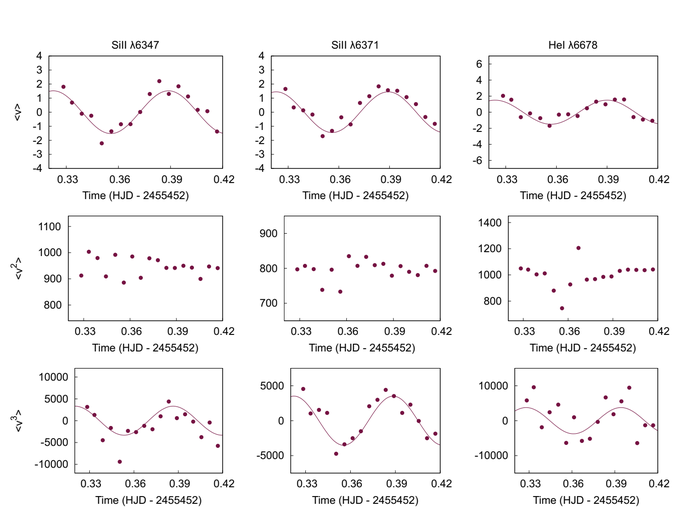
We took 4 time series of spectra in Hα region over timespan of 19 months



From the observations we were able to investigate time series of the moments of three photospheric lines (two lines of SiII and one line of HeI, see Kraus et al. 2012)

Results

In the time series of the first three moments it is possible to see that the first and the third moment are changing periodically.

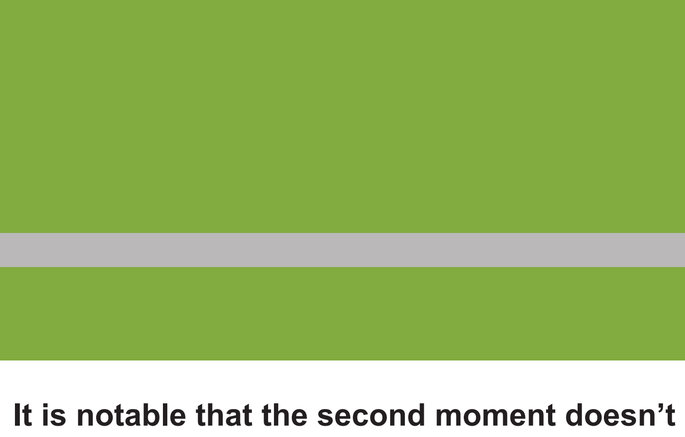


In the previous picture it is possible to see how the moments change with time. These moments are calculated from the spectra taken in a single night (12/9/2010).

The change in the first and third moment is synchronized which points towards pulsations as physical origin. From these two moment we were able to recover the period.

It is notable that the second moment doesn't show periodicity on the same scale as other two moments. It is expected for the second moment to behave differently than the other two due to pulsations, but in this case the moment is affected by the noise too much to recover the period from it.

We were able to recover the same period of 1.59 hours from the first and the third moments claculated from the time series taken on nights of 12/9/2010 and 26/2/2012. The other two time series we took don't cover enough time to extract the period from them, but when phased fit the detected period.



The previous picture shows the phased moments from all the nights. It is possible to see that the first and the third moment are synchronized. The second moments seem to show some regularity when all the data is shown on the single plot. It seems that the second moment has double period, but the data is not good enough to make a definite conclusion about it.

Conclusions

- **The periodical change in the radial velocity and the measure of the width is observed.**
- **This change is synchronized for three photospherical lines of two different elements.**
- **This cycle is stable over period of 2 years**
- **Physical cause of this periodical change in these lines is the stellar pulsation**
- **HD 202850 falls outside any known instability domains**
- **The second moment is too affected by the noise and because of that we cannot determine the exact pulsation mode.**

References

[1] Detection of 1.59 h period in B supergiant star HD 202850, M. Kraus, S.Tomić,M. Oksala, M. Smole, A&A 542,L32 2012

[2] Astroseismology, C. Aerts, J. Christensen-Dalsgaard and D.W. Kurtz, Springer 2010