COMPARISON OF δ SCUTI AND γ DORADUS STARS

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Introduction

δ Scuti and γ Doradus stars are remarkable pulsating variables for asteroseismology. The discoveries of space telescopes increased their numbers significantly and many problems concerning these stars have been revealed. What are the exact locations of δ Scuti and γ Doradus stars' instability strips? How strong are the relations between rotational velocity and pulsation period and amplitude? These are some of the most important questions to be answered. For these reasons, we performed detailed spectroscopic studies of a sample of δ Scuti and γ Doradus stars. The atmospheric parameters (effective temperature, surface gravity, microturbulent velocity) and projected rotational velocities were obtained by using exactly the same methods for both types of variables. The atmospheric chemical abundances of the analysed stars were derived by using the spectrum synthesis method. Finally, the relations between pulsation period, amplitude and atmospheric parameters, rotation velocity and metallicity were examined. Additionally, the chemical abundance patterns of both types of pulsating stars were compared with each other and with non-pulsating stars. In this poster, the results of this investigation are shown.

δ Scuti Stars

The high-resolution and high S/N spectra of 41 δ Sct variables were analysed (Kahraman Aliçavuş et al., in preparation). The spectral and luminosity types of stars were found to be F5-A1 and III-V, respectively. The spectrum synthesis method was used during the spectral analysis. The distributions of the obtained atmospheric parameters, effective temperature ($T_{\rm eff}$), surface gravity ($\log g$) and microturbulent velocity (ξ) are demonstrated in Figure 1.

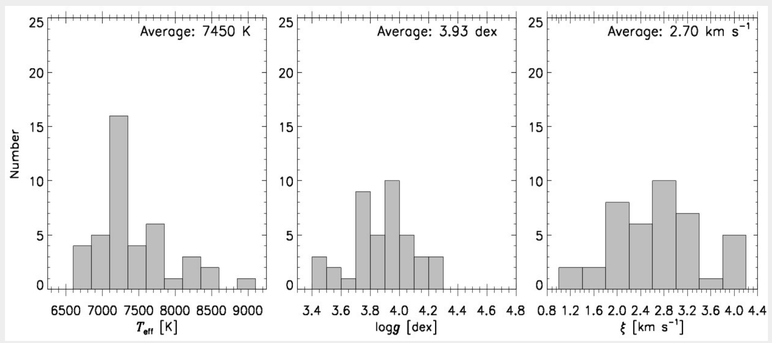

Figure 1. The distributions of atmospheric parameters of δ Sct stars.

The Vsini distribution for δ Sct stars is given in Figure 2. The Vsini values range from 10 to 227 km/s.

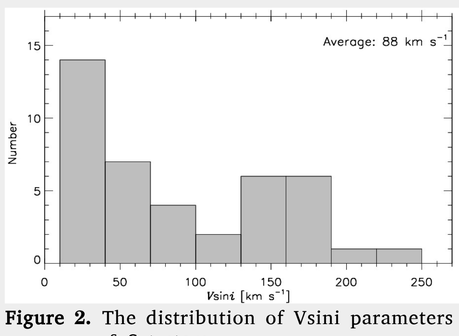

Figure 2. The distribution of Vsini parameters δ Sct stars.

Abundance analysis

The abundance analysis of stars was performed by applying the spectrum synthesis and profile fitting methods. In the analysis, three Am stars were found. The average [Fe/H] value of δ Sct stars was obtained as -0.03 dex. The abundance pattern of these stars is shown in Figure 3.

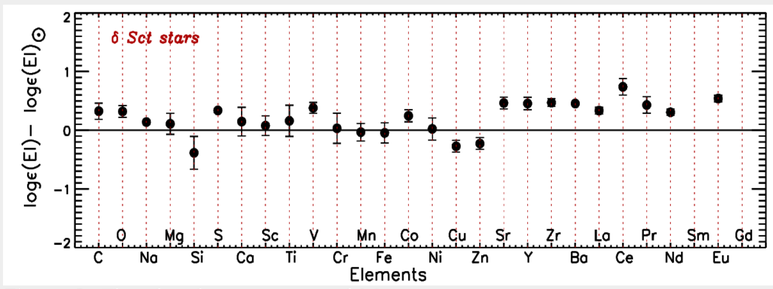

Figure 3. The abundance pattern of δ Sct stars.

Correlations between the pulsation quantities and obtained parameters of δ Sct stars

The relations between the pulsation quantities (pulsation period and amplitude) and derived parameters for δ Sct stars were examined. A significant inverse correlation was found between pulsation period and $T_{\rm eff}$ as shown in Figure 4. Additionally, a probable correlation exists between pulsation amplitude and $T_{\rm eff}$. According to this correlation, the pulsation amplitudes of δ Sct stars decrease with increasing $T_{\rm eff}$ values.

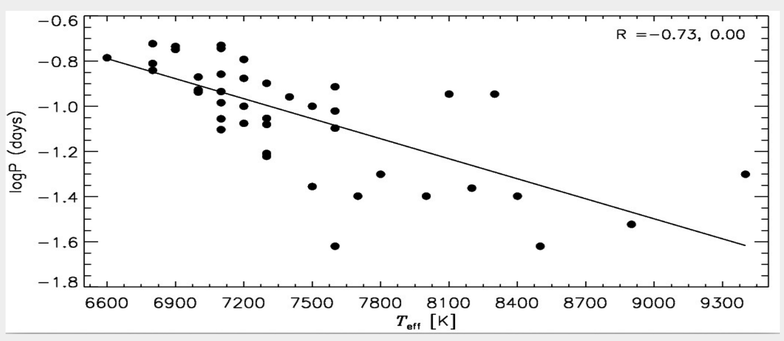

Figure 4. The correlation between $T_{\rm eff}$ and pulsation period. First and second number in the legend show the strength of correlation (in ideal case close to 1) and deviation of points from the correlation (in ideal case close to 0), respectively.

γ Doradus Stars

The high-resolution and high S/N spectra of 28 candidate and 24 pure γ Dor variables were analysed (Kahraman Aliçavuş et al., 2016). Here only the pure γ Dor variables were used to make a reliable comparison with the δ Sct stars. The atmospheric parameters were derived using the same methods as for δ Sct stars. The spectral and luminosity types were found to be F3-A8 and IV-V, respectively. The distributions of the obtained $T_{\rm eff}$, log$g$ and ξ are showed in Figure 5.

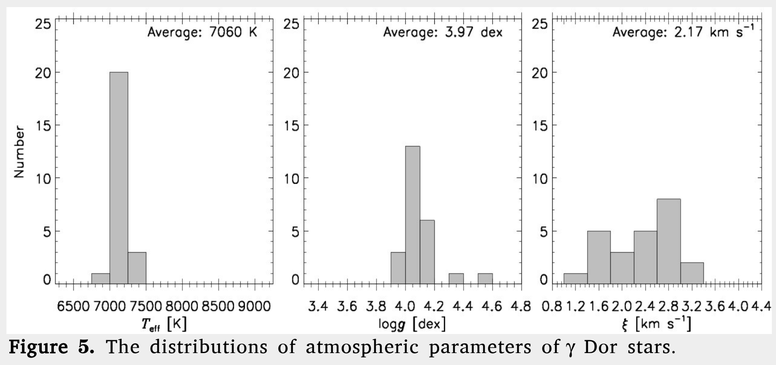

Figure 5. The distributions of atmospheric parameters of γ Dor stars.

The Vsini distribution for γ Dor stars is given in Figure 6. The Vsini values range from 30 to 222 km/s.

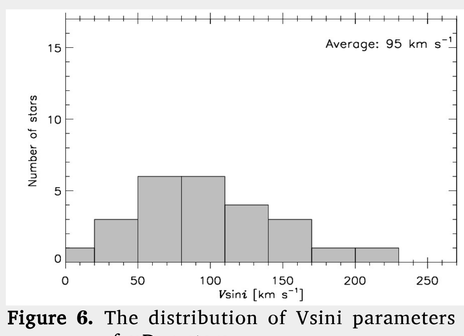

Figure 6. The distribution of Vsini parameters of γ Dor stars.

Abundance analysis

To obtain the abundance pattern of γ Dor stars the same methods as for δ Sct stars were carried out. Any Am star was found in the analysis. The average [Fe/H] value of γ Dor stars was also derived as -0.09 dex. The abundance pattern of these stars is demonstrated in Figure 7.

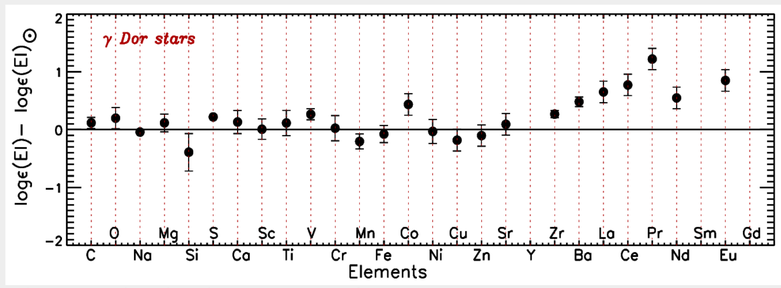

Figure 7. The abundance pattern of γ Sct stars.

Correlations between the pulsation quantities and obtained parameters of γ Dor stars

We analysed all possible correlations between pulsation period, amplitude and the obtained parameters for γ Dor stars. A strong negative correlation was derived between pulsation period and Vsin$i$ as shown in Figure 8. Furthermore, some possible relations were also found between pulsation amplitude and Vsin$i$, [Fe/H], log$g$ and a relation between pulsation period and ξ.

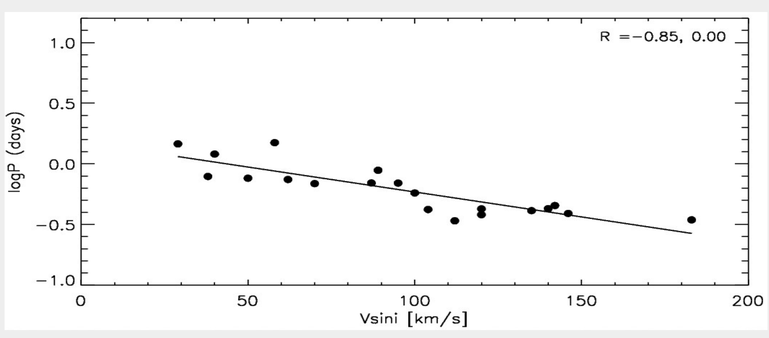

Figure 8. The correlation between Vsini and pulsation quantities. First and second number in the legend show the strength of correlation in ideal case close to 1) and deviation of points from the correlation (in ideal case close to 0, respectively.

Conclusions

We carried out spectral analyses of both δ Sct and γ Dor stars. Thus we had an opportunity to examine and compare these variables in detail. Consequently, we found that:

- Fundamental atmospheric parameters' ranges of δ Sct and γ Dor stars almost cover each other. However, $T_{\rm eff}$ and ξ values for δ Sct stars are higher than γ Dors'.
- Strong inverse and probable correlations are available between pulsation period and $T_{\rm eff}$ for δ Sct and γ Dor stars, respectively. A weak correlation was found between pulsation amplitude and $T_{\rm eff}$ for δ Sct stars as well.
- A correlation between Vsini and pulsation period was found for γ Dor stars. Additionally, the same correlation was obtained for δ Sct stars but it is not so reliable and needs bigger sample to check it.
- It is found that γ Dor stars are located at their own instability strip's bule edge, and δ Sct stars are generally placed in their own domain as shown in Figure 9.
- The δ Sct stars located beyond the blue edge of δ Sct domain (see Figure 9) show lower pulsation amplitudes comparing the other δ Sct samples.

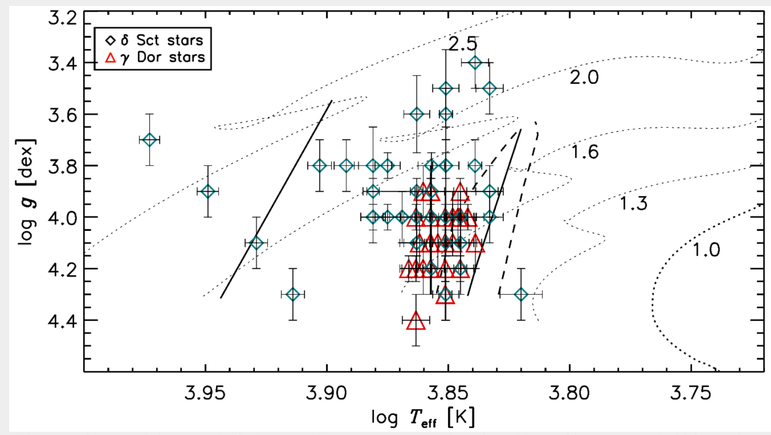

Figure 9. Positions of δ Sct and γ Dor stars in the H-R diagram. Solid and dashed lines represent the instability strips of δ Sct and γ Dor stars, respectively (Dupret et al., 2005).

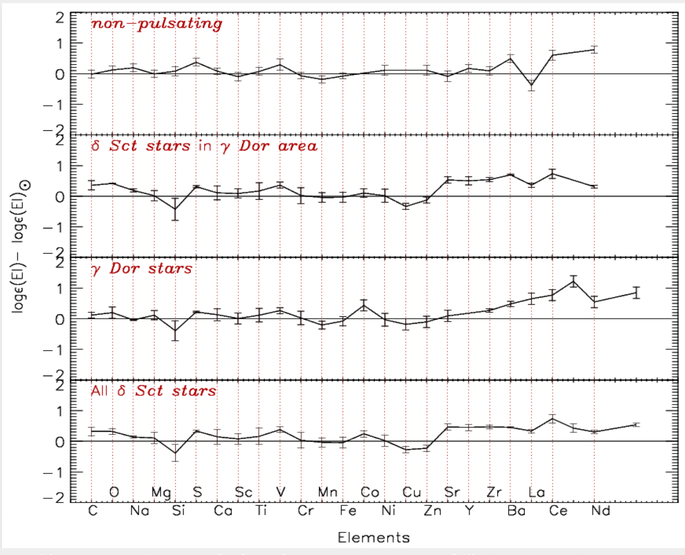

Figure 10. Comparisons of abundance patterns of δ Sct (in γ Dor area and whole sample), γ Dor and non-pulsating stars.

- When we compared the δ Sct stars located in γ Dor area with the other δ Sct stars in δ Sct domain, any difference was found in pulsation periods. However, the average pulsation amplitude of stars in γ Dor area (∼50 mmag) is higher than the others (∼30 mmag).
- We compared chemical abundance patterns of δ Sct, γ Dor and non-pulsating stars (taken from Niemczura et al., 2015) which are shown in Figure 10. It turned out that δ Sct stars in γ Dor area and outside of it have similar abundance patterns with γ Dor stars'. However, both variable types have significantly different abundance patterns than the non-pulsating stars.
- Si abundance is noticeably under-abundant in δ Sct and γ Dor stars than the non-pulsating stars. Conversely, La, Y and Zr abundance are significantly more abundant for both variable stars than the non-pulsating stars. Additionally, Sr and Y abundances in δ Sct stars overabundant relative to γ Dor and non-pulsating stars.

References: 1) Dupret M.-A., Grigahcene A., Garrido R., Gabriel M., Scuflaire R., 2005, A&A, 435, 927, 2) Kahraman Aliçavuş, F.; Niemczura, E.; De Cat, P. et al, 2016, MNRAS, 458, 2307 3)Niemczura E., Murphy S. J., Smalley B. et al., 2015, MNRAS, 450, 2764

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