About the Differential Rotation of A-type Stars

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Abstract. Literature data indicate a significant increase of the differential rotation parameter $\Delta\Omega$ for stars hotter than 6700 K. From the light curves analysis and the specific peak set presence on the power spectra we found that 47 of the 57 objects under review with T_{eff} above 7500 K can be attributed to pulsating stars and only 10 - to stars with brightness variability due to rotational modulation. After excluding pulsating variables for stars with the T_{eff} above 7500 K the average value of $\Delta\Omega$ is 0.051 ± 0.01 $\frac{rad}{day}$.

Keywords: stars: activity; starspots; stars: rotation

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High-precision photometric observations from the Kepler Space Telescope have opened the possibility of studying different kinds of star variability, including those caused by their rotational modulation due to the surface spots presence. Observational signs of stars differential rotation (DR) can be investigated by several methods (see in Savanov et al. 2018). One of them is based on the spotted stars brightness variability power spectrum analysis, the differences in periods founded by the peaks splitting are under study. Using this method T.Reinhold et al. (2013) (based Kepler Q3 data set) and T.Reinhold & L.Gizon (2015) (based on Kepler Q1–Q14 data) analyzed the light curves of 18616 and 12300 of Kepler objects, respectively and calculated the DR parameters α and $\Delta\Omega$. These are the most numerous and uniform data sets of differential rotation parameters α and $\Delta\Omega$ allowing their statistical analysis. Based on T.Reinhold & L.Gizon (2015) a significant increase in the parameter $\Delta\Omega$ for the stars hotter than 6700 K (up to $\Delta\Omega = 0.6$ $\frac{rad}{day}$). The law of DR is described by the equation $\Omega(\theta) = \Omega_{eq}(1 - sin^2(\theta))$, where θ - latitude, $\Delta\Omega = \alpha\Omega_{eq}$.

A number of other studies like A.Reiners (2006); von Eiff & A.Reiners (2012) also indicate that there may be a significant increase in the $\Delta\Omega$ parameter of

A-type and more early stars. The results of these studies are in good agreement with the data from the T.Reinhold & L.Gizon (2015) for objects with temperatures above 8000 K. The data in L.A.Balona (2013) led to the determination of a specific frequencies set, including an isolated peak and a number of smaller amplitude partially-defined peaks in the A-B stars power spectrum. In I.S.Savanov & E.S.Dmitrienko (2019) an attempt to interpret the origin of power spectrums peaks by the presence of spot groups at the different latitudes on the star with surface DR.

The purpose of our study is to analyze the $\Delta\Omega$ parameter for stars with T_{eff} more than 7500 K from T.Reinhold & L.Gizon (2015) (57 objects). We calculated power spectra and analyzed phase curves corresponding to the dominant period of the objects from the Q3 Kepler data. The main result of our analysis is the following. 47 out of 57 light curves in their shape, and the power spectrum by having a specific peak set, can be interpreted as pulsating stars rather than stars with rotational modulation. In addition, the periods of many objects are less than 0.5 - 0.8 days. Only the other 10 can be considered as objects with surface differential rotation. Thus, for the final analysis we have selected 10 stars.

Figure 1 shows the $\Delta\Omega$ - T_{eff} relation. Large dark circles highlight the position of 10 objects we have examined. After deleting the data for the 47 pulsating stars, it was found that for stars with T_{eff} above 7500 K the average value of the $\Delta\Omega = 0.051 \pm 0.01\ \frac{rad}{day}$ (dotted line). Thus, a detailed study of the DR properties of stars with T_{eff} more than 7500 K leads to the conclusion that the value of $\Delta\Omega$ is lower for them than was obtained in the T.Reinhold & L.Gizon (2015) and von Eiff & A.Reiners (2012).

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Part IV

Radio and Neutrino Astronomy