Ultra-fast rotators from Kepler observations

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Abstract

Based on the measurement of the rotation periods 34030 stars on observations with the Kepler space telescope, we make a study of objects with the fastest rotation and estimate an activity indicator, spottedness of stars. Parameters are obtained and investigated for two-types of samples containing 670 and 235 stars with P <1 day and P <0.5 days, respectively.

1 Introduction

Observations with the Kepler space telescope opened up possibilities for determining the rotation periods of thousands of stars. The periods (P) of rotation of stars are determined by studying the rotational modulation of the brightness caused by the presence of cold spots on their surfaces. Analysis of the obtained information on rotation periods, parameters of differential rotation, cycles of long-term activity, as well as analysis of indicators of photospheric and chromospheric activity give limitations used in the construction of theoretical models for the generation of magnetic fields by a dynamo mechanism.

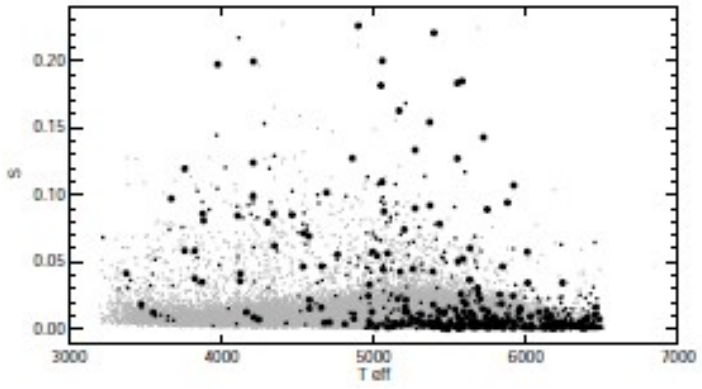

Figure 1: Dependence of the parameter S on the effective temperature for the stars of the catalog [2] (bright symbols). Dark fine and large circles represent the UFR stars with $P < 1$ and $P < 0.5$ days, respectively.

Our particular interest of objects are the rapidly rotating dwarfs and subgiants (see [1]). The values of their rotation periods are less than 1.0 or even less than 0.5 days. Such stars are often called ultra-fast rotators (UFR). References to some UFR analyses can be found in [1]. In the literature, the most extensive studies are presented for the UFR stars like Seedy Mic ($P = 0.3804$ days), AB Dor ($P = 0.5139$ days), HK Aqr ($P = 0.4312$ days), and LO Peg ($P = 0.4231$ days). Total number studied UFR objects lags behind small.

Based on the measurement of the rotation periods of 34030 stars on observations with the Kepler space telescope [2], we have estimated the one of the activity indicators of the group of UFR objects and present estimates their spottedness parameter.

2 Spottedness of UFR objects

The catalog [2] includes data for 34030 objects with effective temperatures below 6500 K. For all the stars in the catalog, we analyzed the properties of active regions (cold spots) on their surface. Spottedness (S) of the surface of stars by their photometric observations was determined using the methodology proposed in [3]. The main advantage of this technique is the ability to its use in large samples of objects (in our case 34030 stars) for the purpose of subsequent statistical analysis. The spottedness parameter S is defined as the ratio of the area of all spots to the area of the visible hemisphere of the star. Since we do not know the star's brightness level in the absence of spots on its surface; we can only get the lower limit of the spot content.

Figure 1 shows the dependence of spotedness of stars in the catalogue. Dark small circles shows stars with the rotation periods P is less than 1 day, and the dark large circles stars represent with P <0.5 days.

Data for the vast majority of objects in Fig. 1 is grouped in the region of change of parameter S from 0 to 0.03. The maximum distribution is achieved for objects with T_{eff} about 5300 K, decreasing in the transition to objects with both higher and lower temperatures. This group consists of moderate stars and weak activity (small areas of spots). The second group (small) is formed by objects for which the value of the parameter S is more than 0.03 (active stars).

Among the cataloged data, we found 670 UFR with P < 1 days and 235 UFR with P < 0.5 days. UFR stars belong to the P < 1 d and P < 0.5 groups are termed low-active and active groups. At the same time, among the low-active UFR objects, stars with T_{eff} > 5000 K belong to the least active stars of this group. Out of 670, 474 UFR stars belong to a group of less active stars and 196 to the second active group.

A similar properties of these UFRs are indicated by the dependence of the parameter S on their mass. In that the case of low-active UFR objects are most common among stars with a mass of more than 0.8 $M_{\odot}$.

Both samples of objects (containing 670 and 235 stars with P <1 day and P < 0.5 days, respectively) will serve as a basis for further studying the

properties of UFR objects.

3 Conclusion

We have analysed the results of measurements of the rotational periods of 34030 stars according to the observations with the Kepler space telescope [2] and among them for a group of UFR objects, we present the spottedness, which is regarded as one of the activity parameter. We found two samples of objects containing 670 and 238 stars with P <1 day and P <0.5 day, respectively, which will serve basis for our further analysis.

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Bibliography

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