Stars and their variability observed from space
C. Neiner, W. W. Weiss, D. Baade, R. E. Griffin, C. C. Lovekin, A. F. J. Moffat (eds)

RIEGER-TYPE PERIODICITY IN THE ACTIVITY OF SOLAR-TYPE STARS

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Abstract. Rieger type periodicity occurs in many indices of solar magnetic activity such as: sunspots, solar flares, CME-s, etc. Our recent analysis of long- term sunspot data showed that observed Rieger-type periods correlate with solar cycle strength so that the stronger cycles show shorter periods. This finding allowed us to estimate the magnetic field strength in the solar dynamo layer. Some solar-type stars show short-term variations in magnetic activity, which might correspond to the solar Rieger-type periodicity. We study Kepler light curves to search the periodicities on solar-like stars at different evolutionary stages and use them for an estimation of the stellar dynamo magnetic field.

Keywords: Stars: activity, Stars: magnetic field

1 Introduction

Short-term variations of 155-200 days known as Rieger-type periodicity occur in many indices of solar activity Rieger et al. (1984); Oliver et al. (1998); Zaqarashvili et al. (2010). Our recent analysis of long-term sunspot data showed that observed Rieger periods correlate with solar cycle strength: stronger cycles show shorter periods and this periodicity is smaller in the more active hemisphere in each cycle Gurgenashvili et al. (2016, 2017).

Our main goal during this investigation of stellar activity is to search for Rieger type periodicity, which may give us information regarding the magnetic activity of stars in different phase of evolution. The recent Kepler space mission collected huge amounts of data about stellar activity, which gives an excellent basis to search for Sun-like periodicities in other stars. Observed periodicities in solar-like stars with different rotational periods are very important to understand the development of dynamo activity during stellar evolution.

2 Short-term periods in the activity of Kepler-observed Sun-like stars

Using Kepler data, McQuillan et al. (2014) created a catalogue of more than 34 000 stars with determined rotation periods, where Sun-like stars could be selected by different criteria, such as effective surface temperature (5500-6000 Kelvin for the Sun), stellar surface gravity, log_g (4.2 for the Sun), and rotation period, which varies between 0.5-80 days. As the Rieger type periodicity is 5-6 times longer than the rotation period for the Sun (P_{rot} is 27 days and the Rieger type periodicity is around 150-170 days), therefore we were interested in stars where we could find periods several times longer than the stellar P_{rot}.

From thousands of Sun-like stars we chose one solar type star, with rotation period of about 9.5 days, which shows very clear periodicity of 60-61 days. This star is a younger analog of our Sun. The effective temperature of this star is 5601 K and the (log) surface gravity is 4.906. First we investigated the rotation period of this star quarter by quarter to study the variation of the stellar differential rotation period in detail. Then we performed different types of analysis to justify that the period of 60-61 days really is associated with the stellar activity. We found that this periodicity has stronger power during the first half of the observing interval; it is not instrumental and CCD-dependent and therefore it is related to stellar activity.

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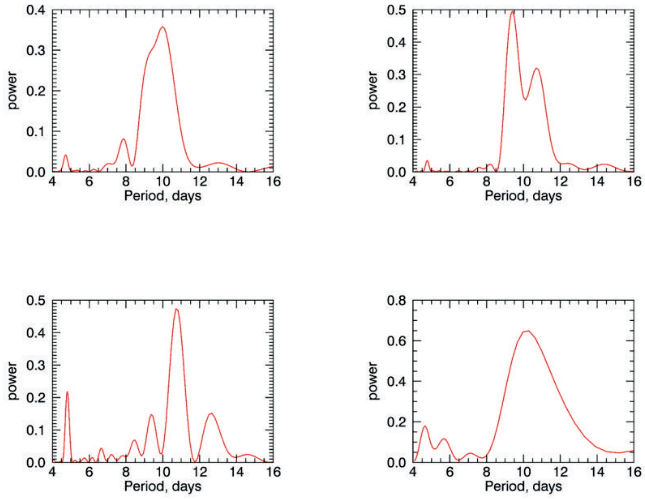

Fig. 1. GLS analysis of a Kepler Sun-like star which is a younger solar analog with rotation period of about 9.5 days. The rotational period is well defined in some quarters and mixed in others, very similar to the Sun. Therefore, the rotation periods might reflect the different phases of stellar activity.

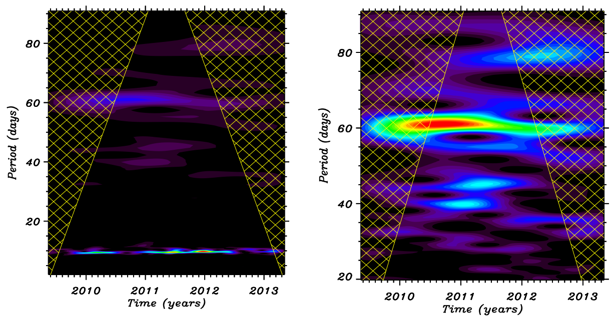

Fig. 2. The 9.5d rotating Kepler Sun-like star. Left panel: full range of periods. Right panel: selected range between 20-90 days. The chosen star shows a period of 60 days, which takes place during the first 8-9 quarters, after which it became less evident.

3 Conclusions

We investigated a Kepler solar-type star which shows similar behavior as the Sun, as the rotation period changes from 9 to 11 days. The rotation period varies in different quarters with various amplitudes. The variation of P_{rot} might mean that it reflects the different phases of stellar magnetic activity. We found very clear periodicity of 58-61 days in the light curve, which is probably due to stellar activity variations and not instrumental. This periodicity has stronger power during the first half of the observational interval, then it disappears.

This work was supported by Georgian SRNSF projects (217146, N04/46, project number N93569) and funded by the Volkswagen Foundation . This paper resulted from discussions at workshops of the ISSI team Rossby waves in astrophysics organized in Bern, Switzerland.

References

Gurgenashvili, E., Zaqarashvili, T. V., Kukhianidze, V., et al. 2016, ApJ, 826, 55

Gurgenashvili, E., Zaqarashvili, T. V., Kukhianidze, V., et al. 2017, ApJ, 845, 137

McQuillan, A., Mazeh, T., & Aigrain, S. 2014, ApJS, 211, 24

Oliver, R., Ballester, J. L., & Baudin, F. 1998, Nature, 394, 552

Rieger, E., Kanbach, G., Reppin, C., et al. 1984, Nature, 312, 623

Zaqarashvili, T. V., Carbonell, M., Oliver, R., & Ballester, J. L. 2010, ApJ, 709, 749