On the magnetic field of red giants ε Tau and ν Oph

V.Butkovskaya[1,2], S.Plachinda[1,2], N.Pankov[1]

[1]Crimean Astrophysical Observatory

[2]Main Astronomical Observatory of NAS of Ukraine

Abstract. We present the results of a search for the magnetic field inhomogeneity for the red giants ε Tau and ν Oph. The study is based on spectropolarimetric observations obtained in 2008-2010 with the ESPaDOnS CFHT. We found some of the lines in spectra of both stars to be distorted by random polarization outliers, presumably of an instrumental nature. Therefore, to measure the magnetic field from the unblended individual lines, we preliminarily cleared the initial array of spectral lines from the lines distorted by the outliers. Calculated in such manner magnetic field of ε Tau exceeds 3σ on one from ten nights. The statistical distribution of the magnetic field of ε Tau shows a deviation from the normal distribution on two nights. We assume this may be due to the inhomogeneity of the magnetic field of the star. No statistically significant magnetic field on ν Oph was found.

Introduction

ε Tau (Sp G9.5 III, HR 1409, HD 28305) is a weakly active red giant belonging to the open cluster of Hyades. It has a massive planet (M_p = 7.1 – 7.6 M_J) orbiting it with a period of 595 days. Aurière et al. (2015) detected a weak magnetic field, |Be|~1.4 G, for ε Tau during the spectropolarimetric monitoring of giant stars with the twin spectropolarimeters ESPaDOnS (CFHT) and Narval at Télescope Bernard Lyot (TBL, Pic du Midi Observatory). Another red giant with close stellar parameters, ν Oph (Sp G9 III, HR 6698, HD 163917), was taken as a control object for which no magnetic field was detected. We re-treated the spectropolarimetric data of both stars from CADC database in order to search for possible inhomogeneity of their magnetic field using own Single Line (SL) technique (Plachinda & Tarasova 1999). The SL- technique allows us to measure the magnetic field by the centers of gravity of the polarized components of individual spectral lines.

Results

We found some of the lines in spectra of both stars to be distorted by random polarization outliers, presumably of an instrumental nature (Fig. 1). Amplitude of these polarization outliers reaches several percent and similar polarization artifacts were detected in all orders on all observation nights. Therefore, to measure the magnetic field using unblended individual lines, we preliminarily cleared the initial array of spectral lines from the lines distorted by the outliers. Calculated in such manner magnetic field of ε Tau exceeds 3σ (B_e = 5.48 $\pm$ 1.56 G) on one from ten nights (Plachinda et al. 2021).

The statistical distribution of the magnetic field of ε Tau shows a deviation from the normal distribution on two nights. In the upper panels of Fig. 2, "B_{null} origin" and "B_e origin" are the distributions of the "null" field and magnetic field measured over all the unblended lines. In the bottom panels, "B_{null} cleared" and "Be cleared" are the distributions of the "null" field and the magnetic field measured with the array of undistorted spectral lines only. We assume, that a reason for the deviation from the normal distribution may be an inhomogeneity of the magnetic field, which is difficult to detect based on a small number of measurements. However, further observations are required to confirm or refute this hypothesis. We also found no magnetic field on ν Oph.

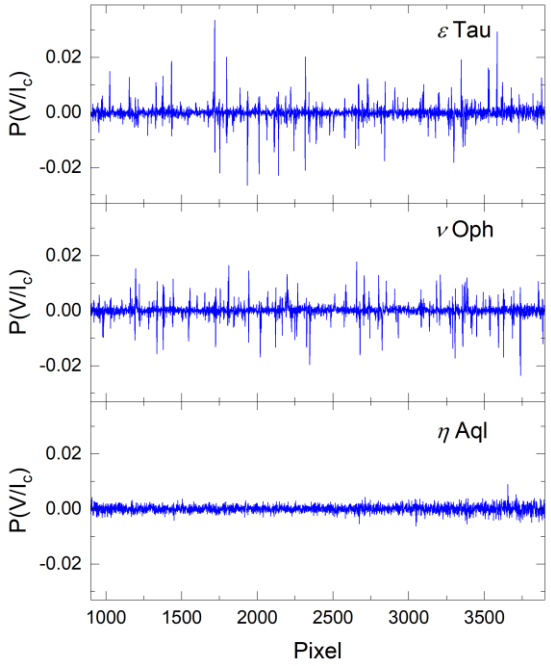

Figure 1. Circular polarization in the spectrum of ε Tau (2008-10-18), ν Oph (2008-10-18), and η Aql (2017-08-08). The Y-axis shows the Stokes V profile, and the X-axis shows the pixel numbers. The edges of the spectra on the blue and red sides are cut off due to the low signal-to-noise ratio.

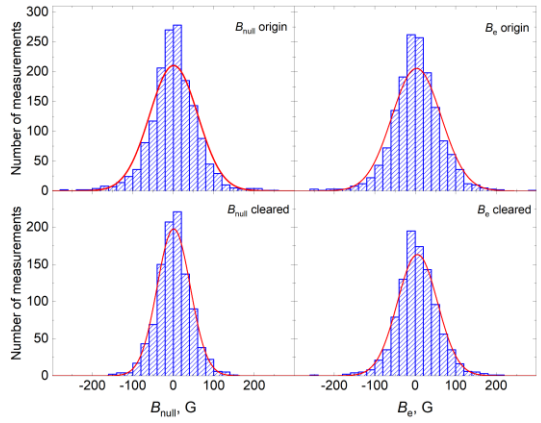

Figure 2. Distribution of the "null" field and the magnetic field of ε Tau measured from individual spectral lines on the date 2008-10-18. The normal distribution curves are shown by solid lines.

References

Aurière, M., Konstantinova-Antova, R., Charbonnel, C. et al. (2015), A&A, 574, A90.

Plachinda, S. I., & Tarasova, T. N. (1999), ApJ, 514, 402.

Plachinda, S., Butkovskaya, V., Pankov, N. (2021), AN, in press, eprint arXiv:2102.03158

Acknowledgments. S. Plachinda acknowledge the support of Ministry of Science and Higher Education of the Russian Federation under Grant number 075-15-2020-780 (N13.1902.21.0039). This study is based on observations obtained at the CFHT. This research used the facilities of the Canadian Astronomy Data Centre operated by the National Research Council of Canada with the support of the Canadian Space Agency.