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Physical variability of the magnetic field of some stars

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The magnetic behavior of red dwarfs shows a change in physical magnetic field parameters in time periods of months–years. We investigate whether a similar variability is possible in stars of other types.

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1 Introduction

The observed variation in longitudinal effective fields at the main mass of stars is due to rotation, i.e. change of projection values of longitudinal magnetic field per vision line. The effect is purely geometric and it has nothing to do with changing the parameters of the magnetic field itself. But in some late stars, there is a change in magnetic phase curves. This indicates a change in the parameters and configuration of the magnetic field, i.e. about the physical variability of the magnetic field. As an example, the variability of magnetic phase curves is given in red dwarfs OT Ser, DS Leo and YZ Cmi.

2 OT Ser

This is a red dwarf star of the spectral type M1.5V and mass 0.55 $M/M_{\odot}$ and is a well known flare star with the period of rotation $P_{\rm rot}$ =3.424 days. Longitudinal magnetic field B_e measurements of the star were published in Donati et al. (2008). Measurements of the magnetic field were carried out in two sets separated approximately by six months. The magnetic behavior of this star significantly changed in this time period.

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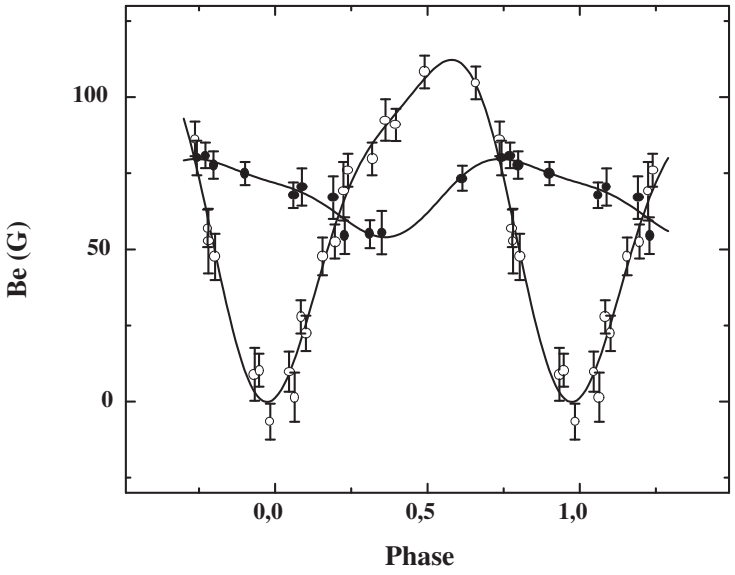


Figure 1 Phase curves of OT Ser obtained from magnetic observations separated by half a year.

Figure 1 shows two magnetic phase curves of OT Ser derived from B_e measurements obtained in both sets. As can be seen from Fig. 1, the magnetic behavior of this object has significantly changed in just half a year.

It is well known that the atmospheres of such stars rotate differentially and this causes constant generation of local magnetic fields on the surface. Due to chaotic motions, lines of force of these local fields sporadically entwine with one another which eventually causes flares in the red dwarf atmosphere. Flare activity in general and even annihilation of the strongest local magnetic fields (superflares) do not affect the global magnetic field of these stars (Bychkov et al. 2015).

Local fields can be generated, accumulate their energy and annihilate in the presence of the global magnetic field. Probably only sometimes local magnetic fields add and reinforce one another and finally form a global magnetic field of a complex structure in some approximation close to the dipole configuration. We believe that such a process was seen in OT Ser. In other words, the parameters of the magnetic field configuration in OT Ser changed considerably in the time period of about six months.

3 DS Leo = HD95650

This is a red dwarf star of the spectral type M0V and mass 0.58 $M/M_\odot$ and is a well known flare star with the period of rotation $P_{\rm rot} = 14.0$ days. Longitudinal magnetic field B_e measurements of the star were published in Donati et al. (2008). Measurements of the magnetic field were carried out in two sets separated approximately by one year. The magnetic behavior of this star significantly changed in this time period (see Fig. 2).

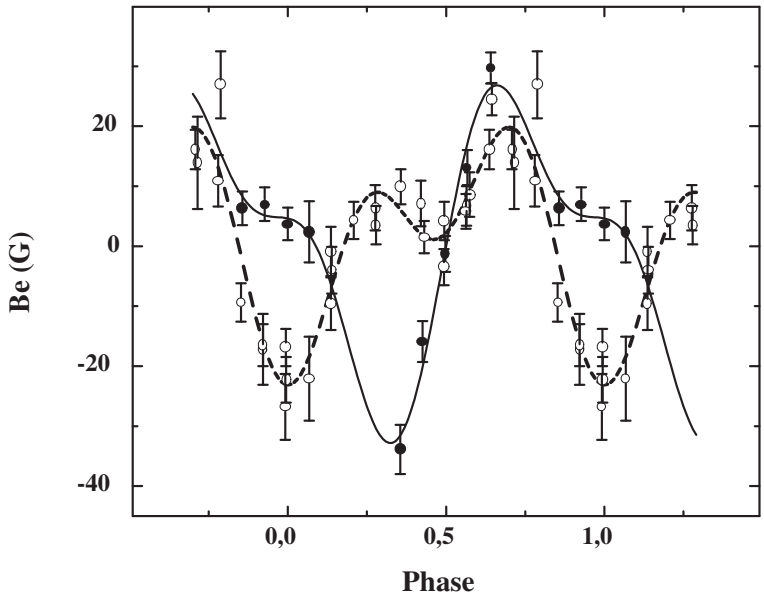


Figure 2 Filled circles – first set, filled circles – second set are data taken from Donati et al. (2008).

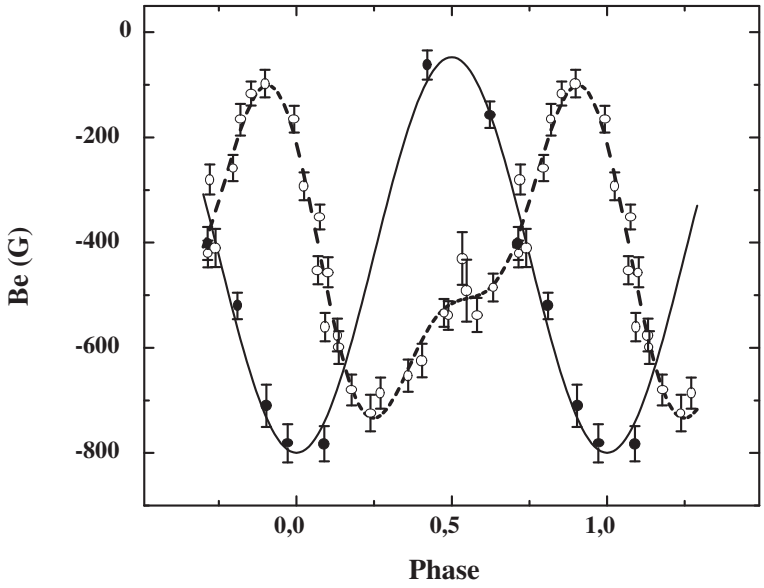


Figure 3 Filled circles – first set, filled circles – second set are data taken from Morin et al. (2008).

4 YZ Cmi

This is a red dwarf star of the spectral type M4.5V and mass 0.31 $M/M_{\odot}$ and is a well known flare star with the period of rotation $P_{\rm rot} = 2.7758$ days. Longitudinal magnetic field B_e measurements of the star were published in Morin et al. (2008). Measurements of the magnetic field were carried out in two sets, separated approximately by one year. The magnetic behavior of this star significantly changed in this time period (see Fig. 3).

5 Conclusions

This is what it should be. The red dwarfs must rotate differentially. Differential rotation is the generation of local magnetic fields. Mechanical rotation energy is pumped into energy of local magnetic fields. Annihilation of local magnetic fields – flash takes away mechanical energy of rotation by light radiation. Magnetic braking by flash radiation occurs. The rotation energy of stars is much greater than the energy of the global magnetic field and may well ensure the operation of the dynamo mechanism takes away the mechanical energy for magnetic fields. There is a mechanism that forces dwarfs of later types to rotate differentially, which leads to efficient operation of local dynamo mechanisms for generating magnetic fields. Energy stored by local magnetic fields, partially illuminated as a result coronal outbreaks (Bychkov et al. 2017). But coral flares are observed in earlier stars – up to spectral type F, i.e., stars having a convective zone. And if late dwarfs have physical changes in the global magnetic field at sufficiently short times, then you can also detect such changes in more early stars. To study such subtle effects, measurements of very high accuracy will be required. Naturally, special attention should be paid to methodical and instrumental effects that may affect the outcome and lead to misjudgements.

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