INVESTIGATIONS OF THE MAGNETIC FIELDS OF CHEMICALLY PECULIAR STARS OF DIFFERENT AGE

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1. The program of comprehensive investigations of stellar magnetism in the Special Astrophysical Observatory of the USSR AS includes the study of origin and evolution of the stellar magnetic fields in open clusters and associations of different age. In the papers by Borra (1981), Brown et al. (1981) and North and Cramer (1984) have been found some indications on the evolutionary decay of the fossil stellar fields.

2. To get more valid answer on this question and for the quantitative determination of decay time τ , it is necessary to investigate the magnetic fields for rather large number of CP stars in a lot of the star groups within a maximum age range. We have studied 13 open clusters and associations. The magnetic fields of the stars were taken from the literature and for 19 CP stars we measured the fields from the zeeman spectra obtained on the 6-m telescope and with the hydrogen line magnitometer. We have found the mean values of the root-mean-square field $<Be>$ for 61 group stars.

3. The initial stellar field, due to the large plasma conductivity, has the ohmic decay time τ evaluated by exponential law:

$$B = B_o \cdot e^{-t/\tau} .$$

For the stars of spectral type B5 - A0 $\tau \sim 10^{10}$ years. The fig.1a shows a dependence $<Be>$ (lg t) for the open clusters and associations. The mean value $<Be>$ for the groups are marked with filled circles, the vertical lines indicate the dispersion of $<Be>$, the open circles show the data for the clusters which have the values $<Be>$ for small number of stars ($N \leqslant 2$). The curve on the fig.1a shows the exponential law of the field decay. It was constructed by the methd of least squares allowing for the weights of poinrs equal to the number of stars belonging to each group. The decay time $\tau = 6 \cdot 10^8$ years, B_o = 1200 Gs, and this result does not contradict the

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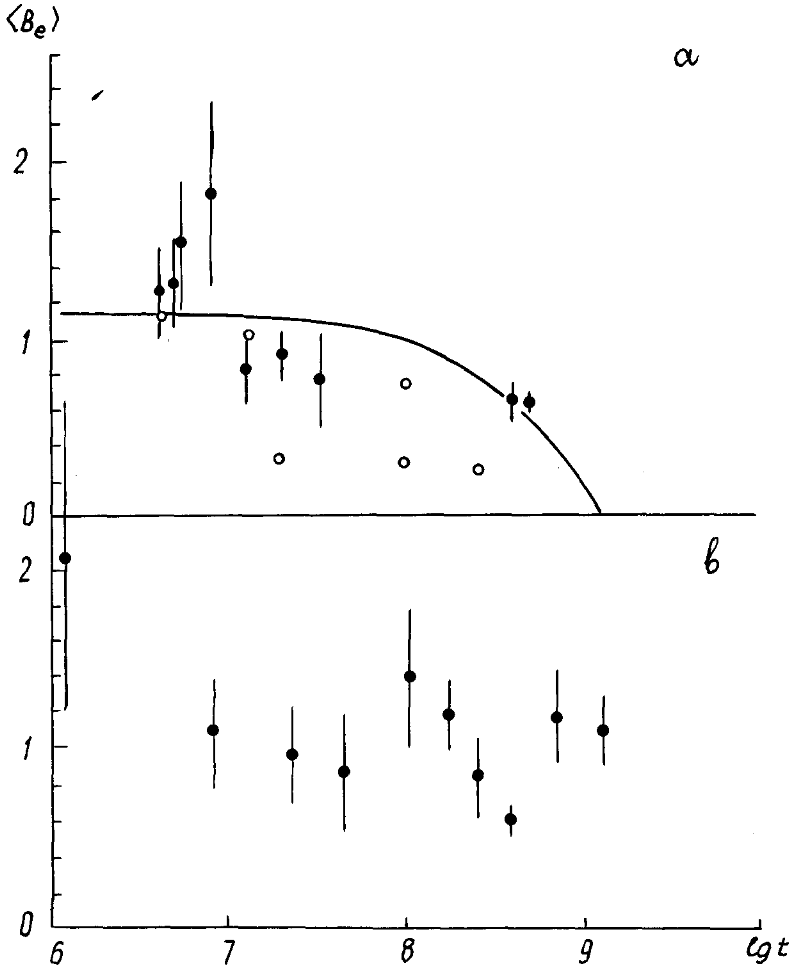

Fig. 1.

assumption about the magnetic field decrease with age, made by Borra, Brown et al. However a large scattering of points in fig.1a does not allow us to speak with a confidence about the field decay or the decay law.

4. To get the additional information about the behaiviour of the magnetic fields of CP stars with age, we have used the data for 71 stars of the galactic field. For each star the age was determined according to their position on the evolution track. The stellar effective temperatures were determined from (B - V) colors, corrected for the interstellar reddening. The absolute magnitudes Mv for the largest part of stars were determined with β-indices. Due to the fact that for cool A stars the β-indices can not be reliable indicators of luminosity, we de-

termined their Mv with help of Mv(Sp) dependences (Straizis, Kuriliene, 1981). The quantitative spectral classes for these stars have been determined from $(B - V)_0$ according to calibration Sp(B - V) (Страйжис, 1977). The dependence $\langle Be \rangle$ (lg t) for field stars presented in fig.1b shows, that the field dissipation is not discovered.

5. All the selected magnetic stars, both in the galactic field and in clusters (132 stars), we divided into 10 age groups with the equal number of stars in each ones. These data are plotted in fig.2. One can see that the mean values $\langle Be \rangle$ do not change in the wide range of age. This conclusion is supported by the dispersion analysis of $\langle Be \rangle$ for the whole number of stars of different age both in the galactic field and in the clusters.

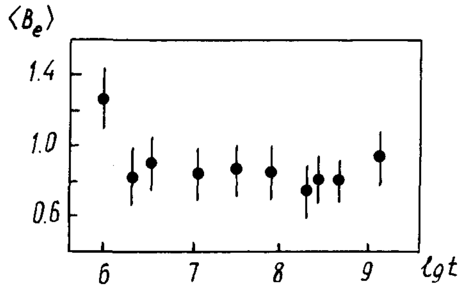

Fig. 2.

6. One can attempt to expose the probable changes of $\langle Be \rangle$ with age for the stars of different masses. For this purpose we estimated the mass for each star on the basis of its position on the evolution track on Mbol (lg Te) diagram. All the stars are divided into 3 groups depending on its mass:

1. massive stars: $\mathfrak{M} > 5\ \mathfrak{M}_\odot$ (22 stars),
2. stars with intermediate mass: $\mathfrak{M} \approx 3 - 5\ \mathfrak{M}_\odot$ (46 stars),
3. stars with small mass: $\mathfrak{M} < 3\ \mathfrak{M}_\odot$ (64 stars).

After that procedure all the stars in each group were divided into 4 equal subgroups a, b, c, d depending on the degree of their deviation from the zero age line. Inside each of the groups there appeared the stars being at close evolution stages. For each subgroup the mean values of the field $\langle Be \rangle$ were determined depending on the mean subgroup age. They are plotted in fig.3. This figure shows that values $\langle Be \rangle$ of the massive stars are systematically higher than those of both the middle mass stars and small mass stars, but the significance of differences is nonimportant and does not exceed 80%. The mean magnetic field Be for each of the three groups 1,2,3, decreases $\sim$1,5 times during the evolution of CP stars from the zero age line up to the upper boundary of main sequence, but the significance of these differences is low.

Thus on the basis our results it is impossible to make a final conclusion about the magnetic field decay of CP stars with age during their evolution across the main sequence.

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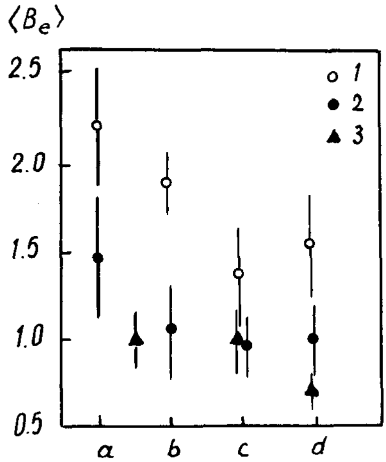

Fig.3.

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