SPECTROSCOPY OF CP STARS IN THE GROUPS OF DIFFERENT AGE

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ABSTRACT. The observational results for 108 stars, members of 10 galactic groups at the age range of lg t = = 6,4 - 8,7 (years), are briefly described. It is shown that the peculiarity index, rotational velocity and magnetic field strength of all the types of CP stars do not vary during their evolution across the main sequence stripe.

The most direct way for studiing the evolution of chemically peculiar (CP) stars is their observation in stellar groups for whose members one can suppose the close age and the similarity of the initial chemical composition.

Due to the wide variety of observational peculiarities in individual CP stars, a problem of the comparative analysis of the main parameters for these objects gets a statistical character (Hartoog, 1977; Abt, 1979; Wolff, 1981). It is necessary to study a rather large sample of CP stars of different peculiarity type in a large age range.

Observation of Bp, Ap stars, members of galactic clusters and associations of different age, there been carried out on the 6-meter telescope in 1978 - 1984 (Klochkova, Kopylov, 1985 a,b). The aim of this extensive program was to determine the quantitative characteristics of peculiar stars on the base of homogeneous spectral material of high resolution and in the framework of the common methods, to elicity the facts of possible dependence of spectral and physical parameters upon the ages of stars and to check the existing hypotheses on the origin and evolution of CP stars.

At the present time the set of parameters for 108 stars, members of 10 groups in the age range lg t = 6,4 - - 8,7 (t is given in years), have been determined. For each star 3 - 5 spectrograms with dispersion of 9 Å/mm (spectral resolution $\Delta\lambda$ = 0,25 Å, spectral range λ3900-

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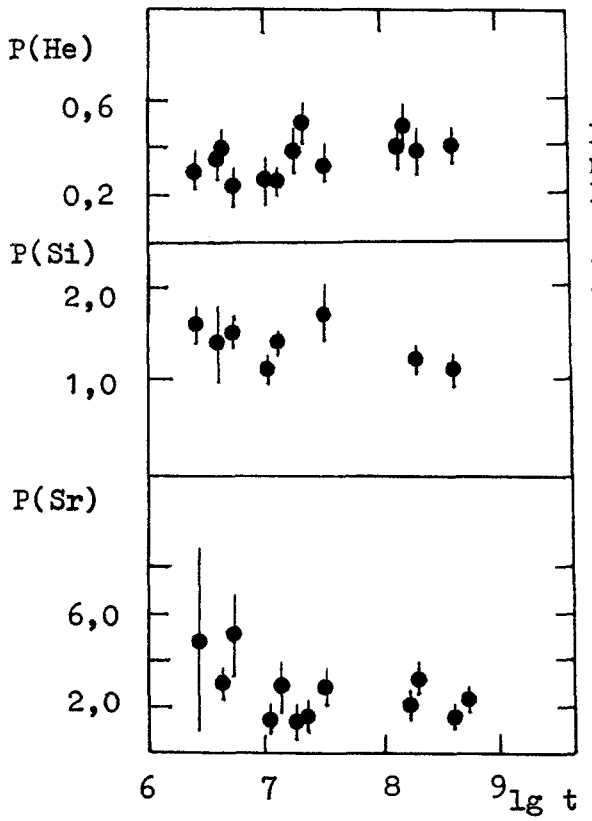

Fig 1. A dependence of mean quantitative index P(He), P(Si), and P(Sr) for CP stars in stellar groups on the age of a group.

The rotational velocities were considered separately for CP stars of four peculiarity types: 1) He-weak stars (n = 90), 2) SiII λ4200 and (or) SiII stars (n = 49), 3) stars with strengthened SrII, CrII, EuII lines (n = 22), 4) Hg,Mn stars (n = 46). A great number of stars reveal several types of peculiarity simultaneously. The analysis of v sin i of CP stars has been carried out for the normalized rotational indices R according to the definition by Hartoog (1977):

$$R = v \sin i(CP) \,/\, \overline{v \sin i(norm)} \quad ,$$

where v sin i(CP) is compared with averaged v sin i for normal stars in this cluster within the corresponding spectral type interval.

It was shown that for studied sample of clusters the $\bar{R}$ values do not correlate with age. We can draw a conclusion that there are no any significant losses of angular momentum by all the types of CP stars during their evolution within the MS stripe.

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- 4900 Å) have been obtained. The minimum W_λ, measured with confidence, was near 30 mÅ.

We have determined spectral classes $Sp(B-V)_o$, Sp(Fe,Ti), $Mv(\beta)$, effective temperature Te, surface gravity lg g and rotational velocity v sin i. Index of peculiarity P is used for the quantitative characteristic of anomalous chemical composition of peculiar star atmospheres. Peculiarity index P is the ratio of W_λ for the line of some given element in the spectrum of studied CP star (i.e. He, Mn, Mg, Si, Sr, Cr, Eu) to the extremely possible (allowing for the errors) value of this W_λ in the spectra of normal stars with the same $Sp(B-V)_o$.

Age for each stellar group was found in conventional manner. The table presents the name of group, its age lg t, quota q % of CP stars among the stars of spectral classes B2 - A7 on the main sequence (MS), and the number n of the studied Bp, Ap stars.

Group	lg t	q	n	Group	lg t	q	n
Ori OB 1a	7,3	11	7	α Per	7,3	14	5
Ori OB 1b	6,6	8	6	Pleiades gr.	7,5	28	22
Ori OB 1c	6,4	8	11	Pleiades	8,1	6	4
Ori OB 1d	<6,0	0	2	M 39	8,2	10	6
Per OB 2	6,4	6	9	M 34	8,3	27	4
Upper Sco:				U Ma stream	8,6	14	9
nucleus	6,6	14	4	Coma	8,7	18	5
inner zone	6,7	33	13				
east zone	7,0	12	3				
west zone	7,1	22	10	Total			120

Remarks to the table: 1) for Upper Sco zones look for Klochkova et al., 1981; 2) 12 stars from ones of our primary program, at quantitative spectral classification we treated as the normal stars without any spectral anomalies.

The studied stars when plotted on Mv, $Sp(B-V)_o$ diagram, filling the whole band of the MS from zero age main sequence (ZAMS) up to the upper boudary of the MS in the mass range $1,0 \geq \lg M/M_\odot \geq 0,2$.

The correlations of peculiarity indices P of helium, silicon, strontium, etc with the age of the CP stars were analyzed. As the statistical analysis of the P values shows the peculiarity index of CP stars not depends upon their age (see figure). A dependence of the P indices upon the value lg g is not detected also. In this context we can consider lg g as some relative age characteristic of B2 - A7 stars inside the MS boudaries.

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Taking into account the different evolution speed from ZAMS for stars with various masses we divided the program stars (independently on their peculiarity type) into three mass groups: 10 - 3,7 $\mathcal{M}_\odot$; 3,6 - 2,6 $\mathcal{M}_\odot$; and 2,5 - 1,6 $\mathcal{M}_\odot$. There is no definite dependence of $\overline{R}$ value upon the age inside this mass groups; no systematical differences of $\overline{R}$ values between the groups are observed also. The dependence of $\overline{R}$ upon the temperature of stars is revealed for not a single type of peculiarity.

The root-mean-square values of magnetic fields $<Be>$ for 52 stars were calculated using the published data, and our determination of $<Be>$ for 19 cluster CP stars. As the comparison showed there is no any correlation of $<Be>$ and lg t. The cross comparison does not reveal any correlation of $<Be>$ and P(He), P(Si), ... ; v sin i and P(He), P(Si), ...

There is nothing but to suppose that:

a) CP stars become the slow rotators in comparison with the normal stars at the very early stages of stellar formation from the protostellar fragments. In the following evolution of a CP star near ZAMS and across the MS stripe its angular momentum does not suffer essential variations;

b) the magnetic CP stars have became the such ones yet before they came up to the ZAMS;

c) the chemical anomalies on the surface of CP stars begin to reveal themselves just before the ZAMS, when the future CP star approach the most quiet evolution phases - the stages of the ZAMS and the MS.

In the relatively stable atmosphere of slow rotating star rather effective diffusion processes can exist whose time scale is very short in comparison with duration of the MS stage. So the high peculiarity degree even in the youngest CP stars, members of Ori OB1, Per OB2, and innermost zone of Upper Scorpius associations (t $\approx$ 2 - 10 millions years) can be explained.

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