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On the Particular Chemical Composition of Ap-Stars

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The peculiar stars of the Ap-type (Ap-stars) are particularly interesting because of their spectral features. Their spectra show intensive absorption lines of chemical elements, non-inherent to the spectral interval to which they belong (B5—FO). At present it is assumed that it is a result of the particular chemical composition of these stars and that the intensified lines in their spectra are due to the greater abundance of certain elements in the spectroscopically active regions of their atmospheres [1].

The present work was a continuation of the more detailed investigation on the chemical composition of Ap-stars, commenced by one of the authors [2, 3]. For that purpose, using data from the literature [1, 4, 5, 6] information was collected about 30 stars, considerably richer than the one used up to now, as in the case of Renson [4]. Our aim was:

1. To investigate the mutual behaviour of chemical elements at the relative increase of their quantity of some of them;

2. To investigate the behaviour of the individual Ap-stars on the $\log \frac{N_*}{N_\odot}$, z diagram, where N_* is the number of atoms of the respective element in the atmospheres of the particular Ap-stars, and $N_\odot$ — in the solar atmosphere, z being the atomic number.

For that purpose we calculated with regression equations the inclination of the lines k, which present the observed quantities of each couple of chemical elements of the individual Ap-stars. Using these data we constructed the k, z diagrams, choosing as a first element the following elements respectively: Mg, Si, Cr, Eu, Ca, Ti, Sr, Fe, Mn. On these elements we either possess the largest amount of data, or they have already been used by other authors [3, 7] as characteristics of the peculiarity of Ap-stars. The chemical elements thus selected were grouped by Radkov in four groups, as follows:

Group I — elements with a mutual increase of quantities: Mg, Si, Cr, Eu;

Group II — elements with mutually decreasing quantities as regards the elements from Group I: Ca, Ti, Sr;

Group III—Fe — its quantity increases as compared to all remaining elements;

Group IV—Mn — its quantity is in a mixed relation to the other elements.

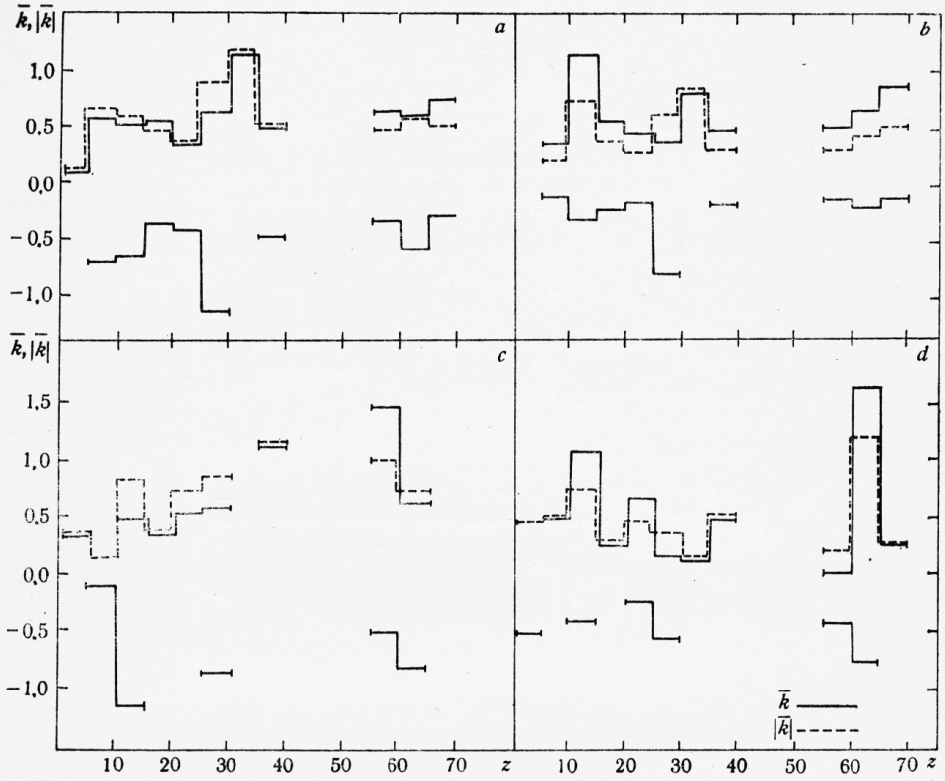

Fig. 1

In all diagrams the distribution of the points showed a certain symmetry on both sides of the z-axis. Moreover, the distribution in the diagram with the first elements from the above groups proved to be similar for a given group. This fact gave us grounds to construct the '$\bar{k}$, z' and '$|\bar{k}|$, z' histograms, where k are, respectively, the mean values of k for which we have taken as first elements the ones from the groups pointed out — Fig. 1*a*, *b*, *c*, *d*. In general (with the exception of the fourth group — Mn), a tendency toward increase of $\bar{k}$ ($|\bar{k}|$ respectively) with the increase of z up to $z<40$, is to be noticed. This means that the respective increase in the quantities of the separate elements to the quantities of the chemical elements in the above groups is with z. We cannot show a corresponding trend for elements with $z>40$ because of lack of sufficient data.

In our opinion the possible reasons for the above trend are as follows:

1. The light elements, generally speaking, are in greater guantities and it is evident that considerable relative changes cannot be expected.

2. Since the chemical elements are obtained as a result of thermonuclear reactions, it is evident that regardless of the pattern according to which

these reactions take place, the most considerable relative changes will be obtained for elements with a larger z.

We must note that in the fourth group of histogram (Fig. 1*d*), $|\bar{k}|$ decreases with the increase of z, in contrast to the rest of the histo-

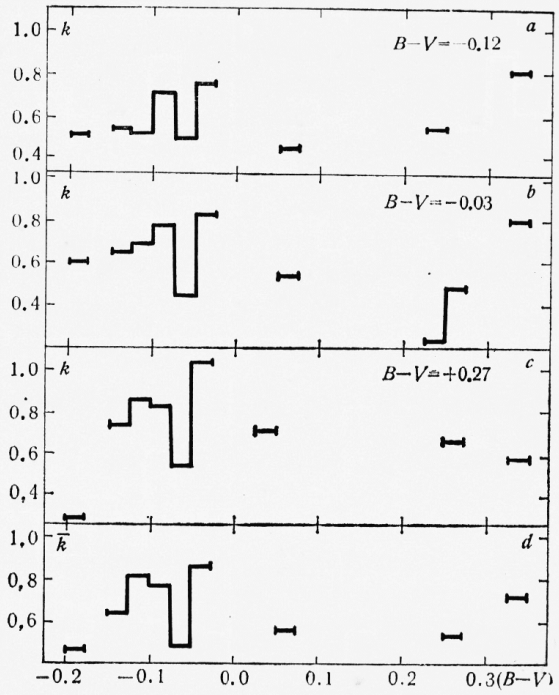

Fig. 2

grams. This may occur as a result of the specific role of Mn in the patterns of the respective thermonuclear reactions. Its place is particular also in the grouping made by Radkov [3], where Mn is in an interrelation to the remaining elements in the groups.

In order to investigate the behaviour of the individual Ap-stars in the '$\log \frac{N_*}{N_\odot}, z$' diagram, we calculated the angular coefficients of the regression lines for each couple of stars for which we have had the corresponding data (definite chemical composition). It was found that for all well observed stars the quantities of the chemical elements increase simultaneously (there is an exception only for stars with very scanty data about these chemical elements). We constructed the 'k, $(B-V)$' diagrams taking some well observed stars as first ones, two for each of the following cases: for stars with $(B-V)=-0.12$, with $(B-V)=-0.03$ and with $(B-V)=+0.27$, which corresponds to early typical and late type Ap-stars. In all three cases a weak tendency to an increase of, k, with $(B-V)$ in the beginning of the diagrams was observed. No considerable difference among them was noticed. This is presented in the histograms separately for the three values of $(B-V)$ and in the general histogram — Fig. 2*a*, *b*, *c*, *d*. In our view, the fact that the trend persists for all values of $(B-V)$ pre-

sents the general tendency towards increase in the quantity of the chemical elements with z [2, 4].

However, the tendency of an increase of 'k' with $(B-V)$ in the beginning may be a smooth transition from Ap-stars to the normal early stars. Such a process is observed also between the amplitude of the radial common magnetic field and $(B-V)$ [8].

We cannot determine the behaviour of the later Ap-stars in all the diagrams examined by us because of the small number of observational data.

In this connection we have to note that the examined tendency of increase of k with z for $z<40$ (Fig. 1) refers mainly to early Ap-stars.

From the presented behaviour of Ap-stars in respect to their surface chemical composition we may draw the conclusion that the increase in the quantities of the chemical elements with the increase of z is similar to the individual examined stars of this type. This is in accordance with the similarity observed in the distribution of the '$\log\frac{N_*}{N_\odot}$, $(B-V)$' diagrams, presented by Khokhlova [1], for the Sr and Mn quantities for individual Ap-stars.

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Об особенностях химического состава Ap-звезд

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(Резюме)

По литературным данным проведено статистическое исследование количественного соотношения химических элементов для 30 Ap-звезд, которое касается некоторых выбранных элементов и звезд данного типа. Для выбранных элементов (за исключением Mn) увеличение количества химических элементов с увеличением их атомного номера имеет одинаковый характер. Для ранних Ap-звезд замечена тенденция увеличения углового коэффициента, характеризующего связь количества химических элементов для всякой двойной Ap-звезды, с увеличением их цветового индекса (B—V).

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