β LYRAE - A BINARY SYSTEM WITH ANOMALOUS ABUNDANCES AND MAGNETIC FIELD

M.Yu.Skul'skij
Polytechnical Institute, Lvov, SU-290013, U.S.S.R

ABSTRACT. Study of dependence of chemical abundance on conditions of excitation within the limits which could exist in the atmosphere of bright component have led to conclusion that by no modification of physical parameters a "normal" abundance of chemical elements in the atmosphere can be obtained. The variable effective magnetic field with mean value (-1350±50) Gauss is discovered.

The β Lyrae, a close binary system is at the final stage of active mass transfer (case B mass exchange) from the bright B8III component with the mass of 3,8 $M_\odot$ to the faint A5III component with the mass of 14,6 $M_\odot$ (Skul'skij, 1975a; Burnashev and Skul'skij, 1978). The rate of mass transfer is more than 10^{-5} $M_\odot$ per year. The atmospheric lines of bright component and emission-absorption lines of the circumstellar gas structures are seen in the visible β Lyrae spectrum range. For the first time the chemical abundances of the bright component atmosphere was determined by Boyarchuk (1959). In particular, the excess of He and the deficit of H were found. Hack and Job (1965) has decreased the ratio He/H taking higher temperature excitation. This uncertainty is due to the simultaneous presence of high excitation lines of NII, CII, SiIII and more extensive group of low excitation lines FeI, FeII, TiII, CrI, CrII etc., that requires special examination.

The quantitative analyses of the bright component atmosphere for ten main phases of the orbital period was

C. R. Cowley et al (eds.), Upper Main Sequence Stars with Anomalous Abundances, 365–368.

carried out by the curve of growth method (Skul'skij, 1975b). It was found that the excitation temperature defined in all phases is approximately about the same. But microturbulent velocity is substantially variable: from 5,5 km s^{-1} at the elongations to 18 km s^{-1} at the main minimum phase. It evidences that the shape of bright component is not spherical. The study of abundances at the second minimum where the faint component is not observed has confirmed the considerable deviation from the solar chemical composition. In particular, the excess of He, N, C, S, Si were obtained under all reasonable assumptions on excitation conditions ($10000\ K \leq T \leq 14000\ K$, $1 \leq \lg p_e \leq 4$). The chemical composition is close to the "normal" one only if the lines of high excitation potential arise at the high temperature and low electron pressure and the FeI, FeII, TiII, CrII lines in the more dense layers at lower temperature. For example the plot of the value

$$[X] = \lg \frac{N_{el}}{N_{Fe}} \Big/_{\beta\, Lyr} - \lg \frac{N_{el}}{N_{Fe}} \Big/_{\odot}$$

versus exitation potential ε_i for visible lines of chemical elements is shown in Fig.1 for two cases of the abundance examinations of iron: the first case deals with the mean value of lg N for FeI and FeII (without FeIII lines) and the second one relates to the group of high excitation lines at the presence of FeIII in the spectrum (marked by the asterixes). In both cases $\lg p_e$ is 3. Such a stratification cannot be understood within the assumption of thermodynamical equilibrium. It seems that the atmosphere of bright component has a peculiar structure due to the active mass loss. Besides, Leushin and Snezhko (1980), suggest that matter of this component has been affected in

https://doi.org/10.1017/S0252921100091818 Published online by Cambridge University Press

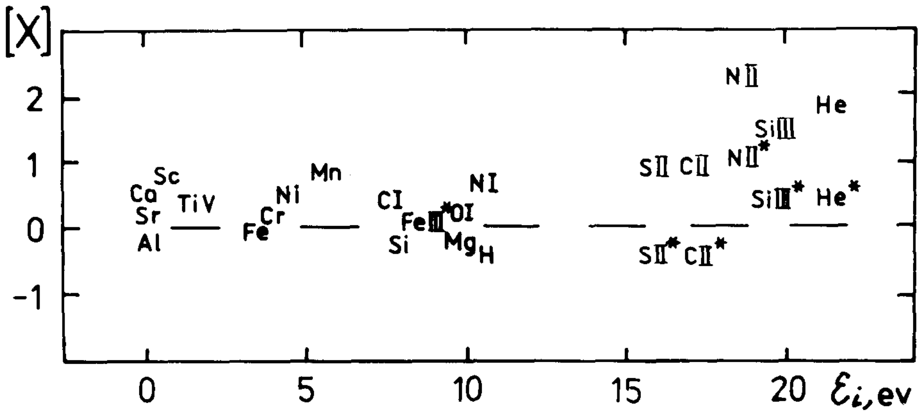

Fig.1. The [X] -index versus excitation potential.

hydrogen burning through CNO-cycle.

In this connection it is interesting that the magnetic field on the surface of the bright component of β Lyrae was discovered (Skul'skij, 1982; Skul'skij, 1985). The measurements of Zeeman splitting of ionized metal lines have been done using 250 spectrograms with dispersion of 9 Å/mm taken with the 6-m telescope in 1980-1984. The effective magnetic field H_e changes with the phase according to the dotted curve (Fig.2) obtained using the approximation of sinusoidal function and taking into account each observation's mean error. The mean value of H_e is (-1350±50) Gauss. Changing together with the orbital period phase with the amplitude of about 500 Gauss it reaches the maximum value near 0.87 P. Moreover, using the absolute spectrophotometric data by Burnashev and Skul'skij (1978) the depression of the continuum at λ 5200 has been found. The depth variation of the depression correlates with the magnetic field changes (Skul'skij, 1985).

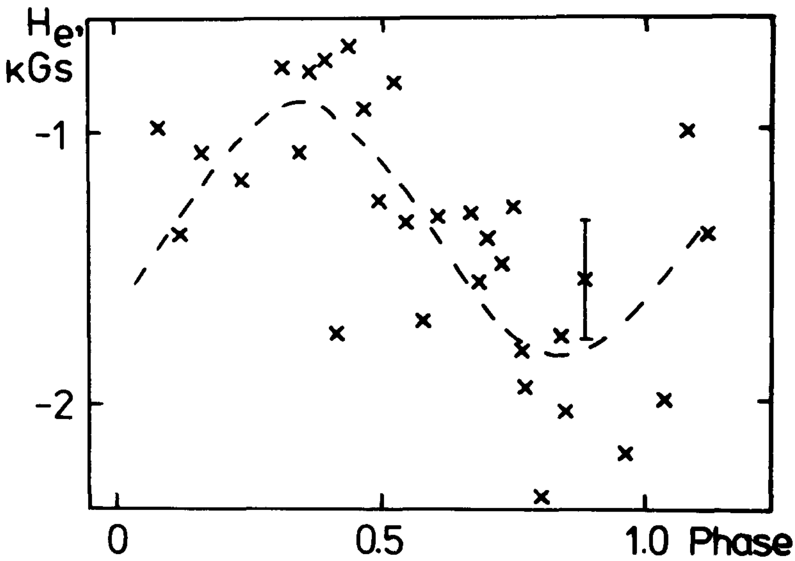

Fig.2. Variation of the effective magnetic field, H_e with the orbital phase. A typical error bar (2σ) is shown for one of the crosses.

References

Boyarchuk A.A. 1959, Sov. astron. J. 36, 5.

Burnashev V.I., Skul'skij M.Yu. 1978, Izv. Krimsk. Obs. 58, 64.

Hack M., Job F. 1965, Zs. Astrophys., B 62, 203.

Leushin V.V., Znezhko L.I. 1980, Pis'ma to Astron. Zh., 6, 171.

Skul'skij M.Yu. 1975a, Sov. Astron.J., 52, 710.

Skul'skij M.Yu. 1975b, In "Problemy cosmicheskoy fiziki", Kiev. University, 10, 160.

Skul'skij M.Yu. 1982, Pis'ma to Astron. Zh., 8, 238.

Skul'skij M.Yu. 1985, Pis'ma to Astron. Zh., 11, 51.