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Spectral classification of stars in the direction of the OB-associations Cygnus OB4, Cepheus-Lacerta OB1 and Cassiopeia OB9

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1. Introduction

The spectral classification based on objective prism plates is a largely applied and very effective method in the astrophysics. As a matter of fact, the analysis of high-dispersion slit spectrograms gives precise and detailed results necessary for revealing the physical structure of the stars and their chemical composition. Nevertheless, many years may pass before we shall be able to give an exact interpretation of all the peculiarities in this kind of spectra. The reason for which the objective prism spectroscopy holds its own field and is irreplaceable is that it allows the principal physical parameters of the stars to be derived by means of a relatively unexpensive technique and simple criteria.

One of the main tasks of the OP-spectroscopy is to cover all the sky by objective prism plates, and that is not only to classify the stars, but also to obtain a large-scale information of spectral classes, absolute magnitudes and colours that would give us the key for determining the distances and the structure of our Galaxy and of other systems too. Simultaneously, the OP-plates provide an excellent means for ready recognising of a great number of special types of stars and other objects.

The OP spectral surveys at dispersion of about 100-200 Å/mm allow almost the same precision of the classification as the slit spectrograms of approximately the same dispersion.

Evidently that is the dispersion which determines the choice of classification criteria, but they depend also on the kind of emulsion, on the seeing, widening of the spectra, wave-length region, density of the spectrograms. There are a lot of specific problems but in general a system of criteria ought to be developed according to each instrument.

Quite logically the automation of the treatment of astronomical data touched the spectral classification from OP-plates too, because of its high-labour consumption, but in many problems the visual spectral classification is still preferred and will be preferred. The point is that human eye is able to distinguish such nuances in the general appearance of a spectrum that could be often

missed and not traced by the microdensitometer. That is the case mainly with narrow weak lines.

The spectral surveys by means of the 8° objective prism of the 70 cm meniscus telescope of the Abastumani Astrophysical Observatory in the USSR are also generally performed by visual inspection of the plates, employing a system of criteria developed by Kharadze and Bartaya (Харадзе Е. К., Бартая Р. А., 1960) which provides homogeneity of the data obtained.

2. Observational material

In the present paper we acquaint the reader with our work on the basis of 48 OP-plates taken by us at Abastumani. The spectra are of 166 Å/mm dispersion, the wave-length region is from 3500 Å to 5000 Å. 4°50′ of the sky is photographed on a plate of 18 cm/18 cm. Exposure time of 20 minutes on emulsion Kodak IIa-0 and widening of the spectra 0,4 mm have been used for classifying the stars, as well as 30 minutes exposure time on emulsion 103a-0 and widening of 0.2 mm have been applied with the aim to avoid the overlapping of the spectra and to reach a higher limiting star magnitude. In this way normally exposed and suitable for classification spectra of stars from 8-8.5 to 11-11.5 photographic magnitude were obtained.

In the table below the limits of the photographed star fields are indicated in equatorial coordinates (1950), as well as the galactic coordinates of the three OB-associations.

Table

Ass	α_{1950}	δ_{1950}	l″	b″
Cyg OB4	$20^h52^m \div 21^h32^m$	$33° \div 42°30'$	$81° \div 84°$	$-8,3° \div 6,3°$
Cep-Lac OB1	$21^h46^m \div 22^h42^m$	$49°30' \div 58°30'$	$99° \div 103°$	$-4° \div 0$
Cas OB9	$23^h06^m \div 23^h56^m$	$54°30' \div 63°30'$	$109° \div 118°$	$-5° \div 0$

3. Results

Guided by the requirement for homogeneity of the results, we had to be sure that in our work we have managed to stick up rigidly to the Abastumani classification system. For that purpose hundreds of investigated formerly stars were reclassified by us. At Fig. 1 a comparison is given of our classification and that of Bartaya independently, of the stars on a plate. The agreement is more than satisfactory. Only then it was considered possible to proceed to the classification of the program stars.

The total number of the stars classified by us is 10889. For more than 60% of them the classification is two-dimensional. For the rest we have determined the spectral type only.

The classification has been accomplished twice, with a suspension of a year; the two results have been averaged. Notwithstanding, the specifying of the classification for each star has been performed on the basis of all the plates where the star was observable. The mean square internal error of the catalogue has been calculated from 600 stars and has been estimated of ± 0.6 of a spectral subclass and ± 0.6 of a class luminosity.

The following spectral subclasses have been used in the classification: BO, 1, 2, 3, 5, 8, 9; AO, 1, 2, 3, 4, 5, 7; FO, 2, 3, 5, 6, 7, 8; GO, 2, 5, 8; KO, 1, 2, 3, 4, 5, 7.

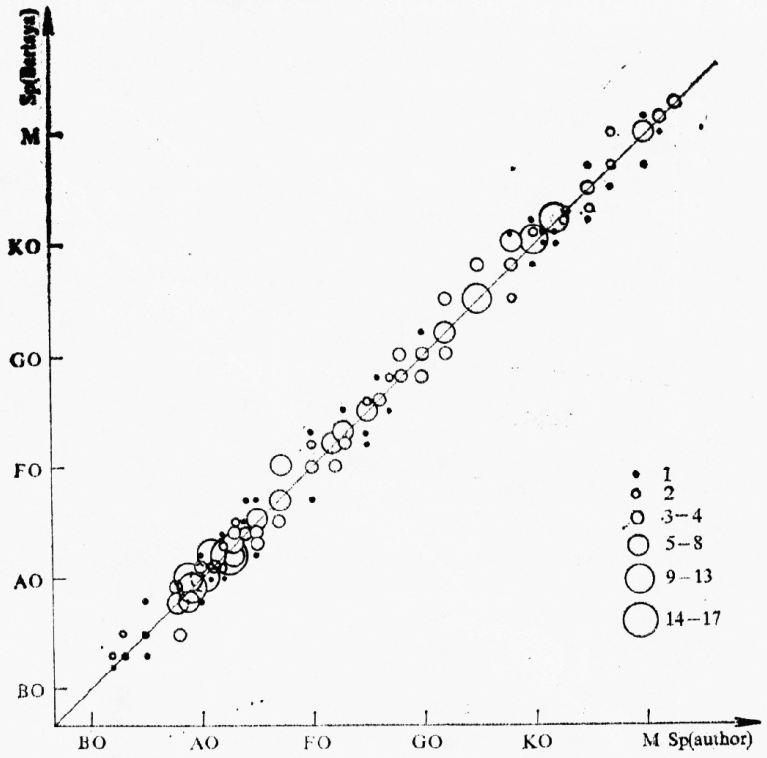

Fig. 1. Comparison of the author's spectral types with those of Bartaya. (The different size of the circles corresponds to different numbers of stars as is indicated in the right corner of the diagram.)

The stars of type M have been divided into three groups: M_a, including the spectra MO-M2; M_b — that of M3 up to M5; and M_c — the spectra later than M5.

The stars up to B2 for which it was considered impossible to provide a strict classification are noted as 0-B2.

In the course of classification 90 peculiar stars of various types have been identified, 73 of them newly-discovered.

4. Discussion

A comparison has been made of the common stars with the HD-catalogue (Fig. 2). A satisfactory agreement has been found keeping in mind some well-known inadequacies of the HD-system.

Fig. 3 gives a comparison based on about 100 stars of our classification with that at the Observatory in Haute-Provence from OP-plates, dispersion 120 Å/mm at H_γ (B o u l o n et al., 1960; G e o r g e l i n, 1967). The agree-

ment is good; evidently the smaller dispersion that we had at our disposal is compensated for by a more distant penetration in the ultraviolet region of the spectrum, as well as by our shorter exposure time which exercises a significant influence on the quality of the spectra. There is a systematic difference in the

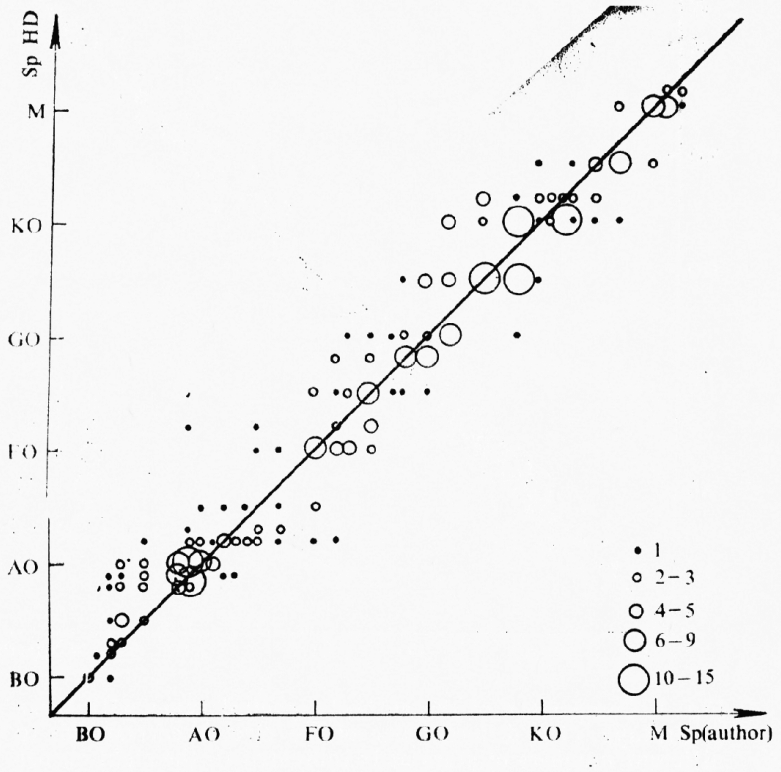

Fig. 2. Comparison of the author's spectral types with those of the HD-catalogue

spectral interval G8-K2 where our spectral subclasses are earlier. The comparison of the classes luminosity is accomplished separately for the spectral groups B0-A9, F0-G2, G5-K7. The histograms show that the luminosity determined by us in the second group is higher.

Fig. 4. presents a comparison with the spectral types of McCuskey (1955) from 4° OP-plates, dispersion 283 Å/mm, on the basis of about 40 common stars of spectral types B0-A0. The earlier subclasses of McCuskey are obviously due to the lower dispersion applied by him; it is known that for these types the spectral features are rather weak lines which become undistinguishable at low dispersion.

Fig. 5 refers to the spectral interval 09-B2, where we have 16 common stars with Guetter (1964) whose spectrograms are slit, 66 Å/mm dispersion. The agreement is quite good.

Fig. 6 shows a comparison with the classification of Yoss (1961) for 16 common stars of spectral types G8-K2. He employs OP-plates of disper-

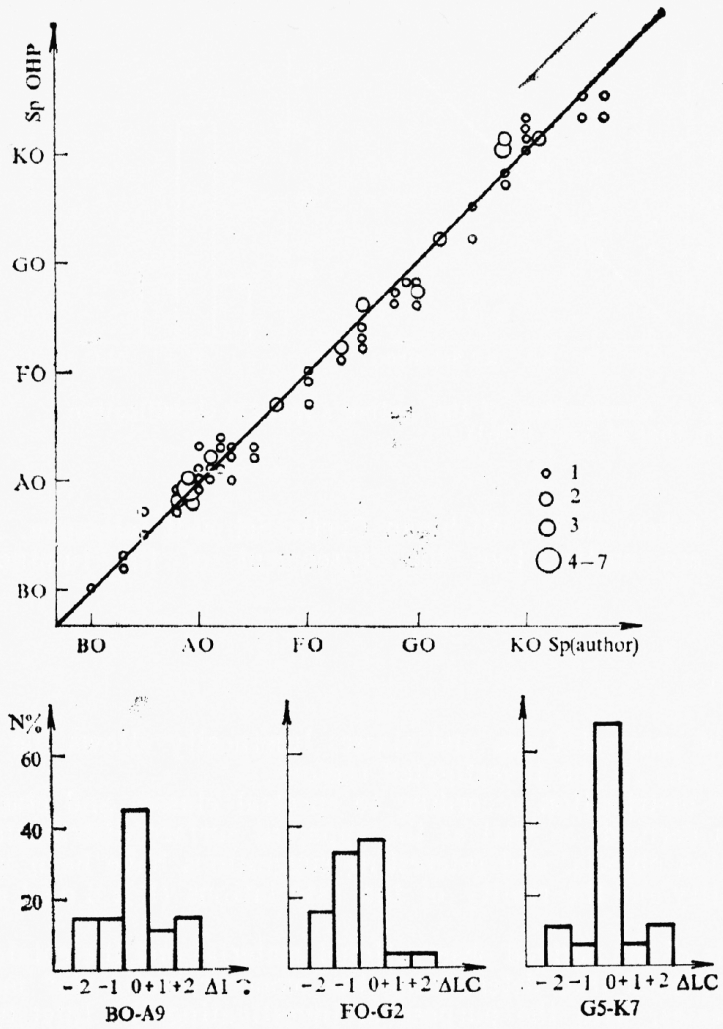

Fig. 3. Comparison of the author's spectral types with those of the Observatory at Haute-Provence. On the histograms below a comparison of the class luminosity is presented. (The ordinate indicates the number of the stars in per cent, the abscissa indicates the difference in the class luminosity: O denotes coincidence, +1 and +2 refer to stars whose luminosity is 1 or 2 classes lower as determined by us; —1 and —2 indicates that our luminosity is higher.

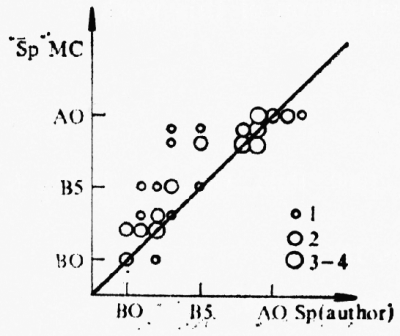

Fig. 4. Comparison of the author's spectral types with those of Mc Cuskey (1955)

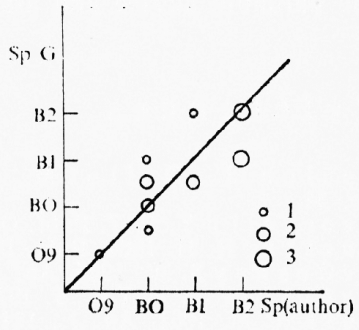

Fig. 5. Comparison of the author's spectral types with those of Guetter (1964)

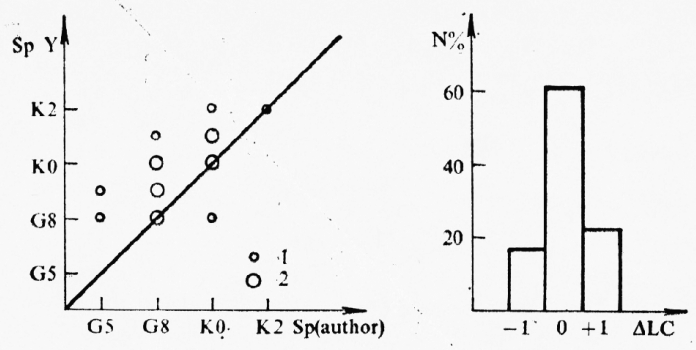

Fig. 6. Comparison of the author's spectral classification with that of Yoss (1961)

sion 110 Å/mm taken on the Michigan Curtis Schmidt telescope. Here our spectral types are earlier too; the agreement of the luminosities is excellent.

5. Conclusion

Our catalogue of spectral types and classes luminosity allows the resolving of various problems in the investigated regions.

So the star distribution according to spectral classes and classes luminosity has been derived, as well as the apparent surface distribution of hot stars and emission objects, and interesting suggestions have been made concerning the locality and the reality of the associations (Radoslavova, 1977).

On the basis of the derived observational material and the catalogue data a research is initiated into determining the monochromatic star magnitudes and colour excesses, with the purpose of investigating the interstellar reddening, the space distribution of stars and the luminosity function in these regions of the sky.

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References

Boulon J., Duflot M., Fehrenbach Ch. 1960. Publ. Obs. H., Prov., **4**, No. 34.
Georgelin Y. 1967. Publ. Obs. H., Prov., **8**, No. 27.
Guetter H. H. 1964. Publ. David Dunlop Obs., **2**, No. 13.
McCuskey S. W. 1955. Ap. J. Suppl., **2**, No. 15, 75.
Radoslavova Tz. S. 1977. Star Cluster Symp., Budapest, 29.
Yoss K. M. 1961. Ap. J., **134**, 809.
Харадзе Е. К., Бартая Р. А. 1960. Бюлл. Абаст. обс., **25**, 139.

Спектральная классификация звезд в направлении OB-ассоциаций Лебедь OB4, Цефей-Ящерица OB1 и Кассиопея OB9

Ц. Ст. Радославова

(Р е з ю м е)

Автор сообщает о своих результатах по визуальной спектральной классификации 10 889 звезд в направлении упомянутых OB-ассоциаций, проделанной по пластинкам, заснятых с помощью предобъективной призмы дисперсии 166 Å/mm. Сделано сравнение классификации звезд, общих с другими авторами. Средняя квадратическая внутренняя ошибка каталога, вычисленная на основе 600 звезд, оценена в $\pm 0{,}6$ спектрального подкласса и $\pm 0{,}6$ класса светимости.

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