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On the third edition of the Almaty "Spectrophotometric Catalogue of Stars"

V.M. Tereschenko*

Fessenkov Astrophysical Institute, Observatory, 23, Almaty 050020, Kazakhstan

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This paper presents brief information about the third edition of the Alma-Ata "Spectrophotometric catalogue of stars" which is the most comprehensive in the world. The new edition of the catalogue has been updated and extended significantly.

Keywords: Stars; Spectrophotometry; Energy distribution; Catalogue

1 Introduction

The Alma-Ata "Spectrophotometric Catalogue of Stars" has gained wide popularity among astronomers. In 2011, the third, supplemented and updated edition of the catalogue was published (Kharitonov et al. 2011). This edition presents the extra-atmospheric energy distribution in the spectral region 320–760 nm for 1273 stars. The spectral resolution of the data is 5 nm. Unlike the previous two editions the data on the energy fluxes from stars are given in the International System (SI) of Units, $[\mathrm{W{\cdot}m^{-2}{\cdot}m^{-1}}]$. Among similar catalogues, our catalogue is the most numerous in the whole world.

The energy distribution in the spectra of stars is used to determine their physical characteristics and values of interstellar absorption. It is also used in the reductions of photometric observations of stars and photometric systems. Stars with known absolute energy distribution serve as "beacons" for rockets and space vehicles. It should, however, be emphasized that our catalogue has gained the popularity due to its data usage for standardization of spectrophotometric observations of other celestial bodies.

The number of stars in the third edition of the catalogue is 10% more than in the second edition. But the main difference and advantage of the current edition is that it represents data for fainter stars (7^m–9^m). On the whole these are the regional standards the data for which has been published in Tereschenko (1994, 2001, 2002). Besides, the third edition comprises the types of stars that are absent in the first two editions. These are stars of spectral classes C and S, late M-giants and M-supergiants and the stars with exoplanets as well.

*Email: volter2307@mail.ru

During the last twenty years practically all characteristics of bright stars have been specified. We can see that from comparison of the fourth and the fifth (electronic) editions of the catalogue of Bright Stars (Hoffleit and Jaschek 1982; Hoffleit et al. 1991). This is especially the case for parallaxes, and for this reason the table in which the basic characteristics of the investigated stars are presented was completely renewed. In the third edition, unlike the second one, the spectrophotometric review is not available. We had confined this to a composite table of references to corresponding papers. Besides, the description of the energy distribution derivation procedure for the primary standards was also greatly reduced. At creation of the Alma-Ata (Kharitonov et al. 1988) and Moscow (Voloshina et al. 1982) Catalogues, eight bright stars were used as standards: β Ari, γ Ori, β Tau, α Leo, η UMa, α Lyr, α Aql and α Peg. But for the observations of regional standards 7^m–9^m the standard was based on the circumpolar star HD221525 [5.58^m, A7 IV] (Tereschenko and Glushkova 1992). Thus, the number of primary standards has increased to nine. The binding to HD221525 was based on its integrated spectrum. The catalogue presents the energy distribution in an integrated spectrum for all standards, and for eight bright standards the distribution in the quasi-continuum spectrum is also given in a special table. The latter was used in the reductions. For each star in the catalogue the standards to which the star is associated are indicated, as well as the number of associations to the standards. In the case of elaborating the energy distribution in the spectra of primary standards it is always possible to perform a necessary reduction for any star.

The equipment, the technique of the observations and their processing are outlined in the catalogue in detail. We note that from the contemporary point of view our observations are performed with obsolete equipment – a single-channel photoelectric spectrometer. Nowadays the majority of astronomers carry out photometric observations with CCD matrices. Unfortunately, currently the accuracy of spectrophotometric observations with CCD cameras concedes to the accuracy of observations with photomultipliers. In our opinion the recession of absolute spectrophotometric observations of stars is connected with difficulties in transition to registration with CCD matrices. The third edition of the catalogue might be considered as a summary of the spectrophotometric observations which were made with a single-channel spectrometer at the Fessenkov Institute over the last 30 years.

All observations are made with the differential method. As a rule, they were performed according to the scheme: "the standard – several program stars – the standard". The method of equal heights, which provides for the maximum productivity of observations and, at the same time, high accuracy, was used. Each star was observed not less than three times on different nights. In the reduction the average value of the coefficient transparency was used. There are no considerable errors for the obtained extra-atmospheric energetic luminosities caused by the terrestrial atmosphere. The proof of that comes from the absence of the dependence of accuracy of observations on the difference of air mass between the observed star and the standard. We also note that there is no dependence of the standard errors on the differences between calculated and directly observed magnitudes and color indices of investigated stars. Thereby there is no dependence of accuracy (standard errors) on the "correctness" of the data.

Spectral radiation was measured with the analog method according to the scheme "photomultiplier – DC amplifier – recorder". The linear dispersion of the monochro-

mator was 28 Å/mm, the spectral resolution depends on the width of the entrance slit. The measurements of the registrogrammes were made by hand.

Unfortunately, at the initial stage of the compilation of the catalogue we committed two errors. Thus, after the first year of observations the shift of "zero" of the entrance slit of spectrometer was noticed. The shift came from the multiple broadening of the entrance slit needed to increase the value of the signal on the recorder. In the mid-1970s, a small nonlinearity of the DC amplifier was found. This nonlinearity had led to a systematic error in the amplification range ratios. After detection of these errors the catalogue data has been corrected with multiplication by corresponding factors but, certainly, "statistically, as a whole".

On average over the spectrum (except for extreme wavelengths) and stars, the relative standard errors of the catalogue data are 3–4%. The majority of them are of hardware origin.

The indirect check of the data in the second catalogue edition (Kharitonov et al. 1988) has shown that systematic errors in our catalogue are absent. The verification was carried out by the comparison of the color indices calculated from the energy distribution with those observed directly. However, considerable divergences do take place occasionally (Tereschenko 2003). Partly they are due to the variability of stars, and partly – due to the errors in our data. It is difficult to pinpoint the unambiguous cause of the divergencies.

Here we show briefly the statistical characteristics of the stellar array of our catalogue. By their visual magnitudes, stars in the catalogue are presented as follows:

m	$<0^m$	0^m–1^m	1^m–2^m	2^m–3^m	3^m–4^m	4^m–5^m	5^m–6^m	6^m–7^m	7^m–8^m	8^m–9^m
n	2	8	16	70	192	426	347	111	69	32

By the spectral classes the stars are presented as follows:

Sp	O	B	A	F	G	K	M	C	S
n	19	283	335	126	161	175	158	13	3

Spectrophotometric Catalogue of Stars is also available as an electronic version.

The third edition of the catalogue is prepared without its principal author, the founder of absolute spectrophotometry in the USSR, our teacher Andrey Vladimirovich Kharitonov. The described edition is the tribute to his memory.

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