AUTOMATIC EXTRACTION AND CLASSIFICATION OF LOW-DISPERSION OBJECTIVE-PRISM STELLAR SPECTRA

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Abstract. An automatic method of spectral classification from low-dispersion objective prism images is developed. The distribution of early- and late-type stars inside stellar complexes and their surrounding regions can lead to important clues on the star formation mechanism. The method is applied to one SMC region.

Key words: methods: data analysis – techniques: spectroscopic

1. INTRODUCTION

Spectral classification is not only a tool for labeling individual stars but is also useful in studies of stellar population synthesis. Extracting physical quantities from digitized spectral plates involves three main stages: detection of spectra, extraction of their images and classification. The detection problem of stars for the digitized objective prism Schmidt plates was discussed by Bratsolis et al. (1998). The purpose of this paper is to present a fully automated method for the extraction and classification of spectra.

High-quality film copies of IIIa-J plates, taken with the 1.2 m UK Schmidt Telescope in Australia, have been used. The spectral plates have a dispersion of 244 nm/mm at $H\gamma$ and spectral range from 320 to 540 nm. The photographic material has been digitized

at the Royal Observatory of Edinburgh using the SuperCOSMOS machine.

2. CLASSIFICATION CRITERIA

OB-spectra. Uniform continuum intensity distribution over the length of the spectrum. The late *B* spectra show Balmer jump in the UV region of the continuum.

A-spectra. Uniform continuum intensity distribution up to a strong Balmer jump at 370 nm. Broad $H\gamma$ absorption line. The absorption line $H\beta$ is evident as a slight narrowing of the spectrum width.

F-spectra. Intensity decreases slowly with decreasing wavelength. The only evident absorption is a blend of $H\gamma$ and G-band. Calcium H and K lines are not visible. This distinguishes F stars from G stars.

G-spectra. Intensity decreases with decreasing wavelength. The strong absorption blend of $H\gamma$ and G-band. Absorption at H and K lines appears. Usually G spectra are shorter than F spectra.

K-spectra. Rapid decrease in intensity with decreasing wavelength. The maximum intensity is between 540 and 430 nm. A broad absorption line of Ca I at 422.7 nm is seen. Calcium H and K lines form a broad absorption at 395 nm.

M-spectra. Very rapid decrease of intensity with decreasing wavelength which is steeper than in K-type stars. The absorption line of Ca I at 422.7 nm and TiO bands at 500 and 480 nm are seen.

Our test image contains a region of the Small Magellanic Cloud of 35×35 arcmin with the center RA (2000) = $1^h 16^m$ and DEC (2000) = $-73^\circ 20'$. The scanning pixel size of SuperCOSMOS measuring machine is 10 μm , and the plate scale is 67.11 arcsec/mm. The classification magnitude limit is $B = 18.5$. The length of spectra is 128 pixels.

3. IMAGE REDUCTION AND SPECTRAL EXTRACTION

The processing of spectral detection (DETSP) is carried out in four stages (Bratsolis et al. 1998): (a) image frame preprocessing, (b) subframe signal processing, (c) detection table processing and (d) detection fine adjustment.

After the spectral detection, a new procedure, responsible for the extraction of spectra (EXTSP), starts on. For a better signal-to-noise ratio, the actual extraction of the spectrum is performed by means of a rectangular weighted “slit” sliding on data. Its width and shape are either fixed or determined by the average fit on the transversal sections of the spectrum.

4. CLASSIFICATION

The classification was tested by four different methods: the human expert (HE), the maximum correlation (MC), the minimum distance (MD) and the artificial neural network (NN) with back-propagation.

To estimate the agreement between different classification methods, we have calculated the mean error me_{hehe} between two human experts a and b , me_{hemc} between human expert and maximum correlation classification, me_{hemd} between human expert and minimum distance classification and me_{henn} between human expert and neural network. The corresponding dispersions σ_{hehe} , σ_{hemc} , σ_{hemd} and σ_{henn} (Bratsolis et al. 2000 and recent results) were calculated.

Table 1. Numbers of stars obtained by different classification methods.

Spectral type	OB	A	F	G	K	M
Class	1	2	3	4	5	6
HE	144	58	27	52	68	77
MC	148	48	32	61	62	75
MD	145	41	38	64	65	73
NN	137	58	35	62	66	68

Table 2. Statistical properties of different classification methods.

Test	me	σ
hehe	0.23	0.47
hemc	0.15	0.43
hemd	0.16	0.45
henn	0.13	0.37

The results from the automated method have been compared with isodensity contour maps described by Maragoudaki et al. (1998) for a better understanding of the SMC star-forming regions.

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REFERENCES

- Bratsolis E., Bellas-Velidis I., Kontizas E., Pasian F., Dapergolas A., Smareglia R. 1998, *A&AS*, 133, 293
- Bratsolis E., Bellas-Velidis I., Dapergolas A., Kontizas E., Kontizas M. 2000, *A&AS*, 142, 339
- Maragoudaki F., Kontizas M., Kontizas E., Dapergolas A., Morgan D. H. 1998, *A&A*, 338, L29