

The region N83-84-85 of the SMC.

Automated classification and study of a possible triggered star formation

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Abstract. The region N83-84-85 belongs to the inner wing of the SMC and is of interest because of its OB associations and nebulae. It is evident that there is a correlation between associations like NGC 456, 460 and 465 with the nebulae of ionized gas. We focus on this region because it seems to show a feedback between OB star formation and the physical properties of the interstellar medium. At the same region have been detected different molecular clouds and HI shells. Stellar spectral classification is not only a tool for labeling individual stars but is also useful in studies of stellar population synthesis. Low-dispersion objective prism images have been used and automated methods of detection, extraction and classification have been developed. We present a classification method based on an artificial neural network and we make a brief presentation of the entire automated system.

Key words. Objective prism stellar spectra, automated detection – extraction – classification, stellar population synthesis, possible supernova explosions

1. Introduction

Large surveys are concerned with two things. The first is finding unusual objects. Once detected, these unusual objects must always be analyzed individually. The second one is to do statistics with large numbers of objects. In this case we need an automated classification system.

High-quality film copies of IIIa-J (broad blue-green band) plates, taken with the 1.2m UK Schmidt Telescope in Australia, have been used. The material has been digitized at the Royal Observatory of Edinburgh using the SuperCOSMOS machine. Our image contains a region of 36.2 arcmin (EW) X 39.1 arcmin (SN) of SMC.

There are three sequential stages of automated processing, detection (DETSP), extraction (EXTSP) and classification (CLASSP) of stellar spectra.

The final aim of this automated method is to study the stellar population synthesis of Magellanic clouds regions.

2. The spectrum detection procedure DETESP

The processing of detection (DESP) is carried out in four sequential stages (Bratsolis et al. 1998):

I. Image frame preprocessing

The whole image frame is filtered by a sequence of median and smoothing filters. A grid of subframes is fixed on the filtered image, according to the overlapping mode.

II. Subframe signal processing

Each one of the fixed subframes is processed by applying the detection algorithm based on a signal processing method. The detected spectral positions are saved in table.

III. Detection table processing

There are possible double detections of spectra near the edges of neighboring subframes. For this reason, the table of detected spectra is now processed to remove the doubling. It is sorted as well.

IV. Detections fine adjustment

The signal processing approach is used again. Now, as many subframes are fixed as the number of detected spectra. The subframes are narrower and each one includes a particular detected spectrum image. This leads to fine adjustment of the position. The adjusted position table is finally sorted.

Details are given in figure 1.

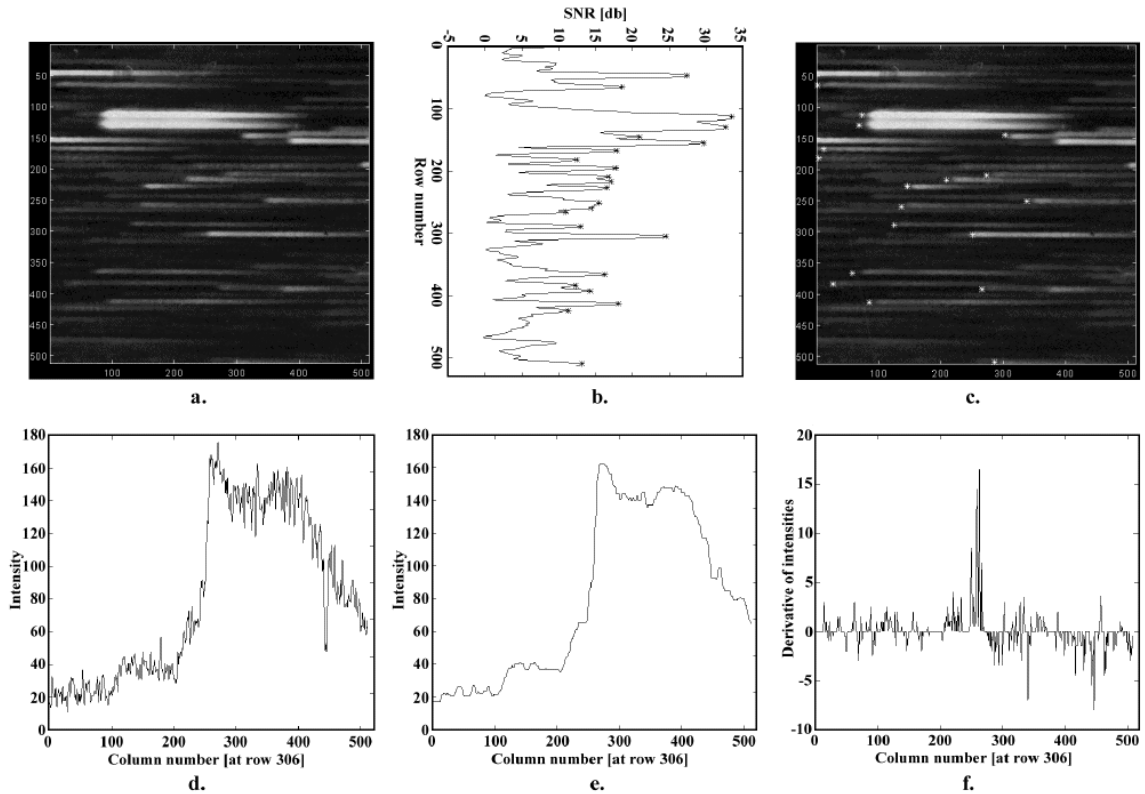


Figure 1: **a.** Initial subframe 512 X 512; **b.** A peak picking to separate the stellar spectrum rows from spurious peaks; **c.** Final results of position determination; **d.** The row 306 as one-dimensional signal; **e.** The row 306 after a median filter and an average filter; **f.** Detective results of filtered row 306

3. The spectral extraction procedure EXTSP

The extracted spectra are stored in a two-dimensional file $n \times 128$, where n is the number of detected spectra. Every row of this file is an independent normalized spectrum with length 128 pixels. The maximum number of spectra used for testing here is $N=426$. The low-dispersion objective prism P1 allow us to classify the stellar spectra only in six classes (OB, A, F, G, K, M). Although the number of classes is limited, the method is useful to study the spatial distribution of stars in groups with the same spectral type. Examples are given in figures 2 and 3.



Figure 2: A sample of $N=426$ normalized spectra with length 128 pixels

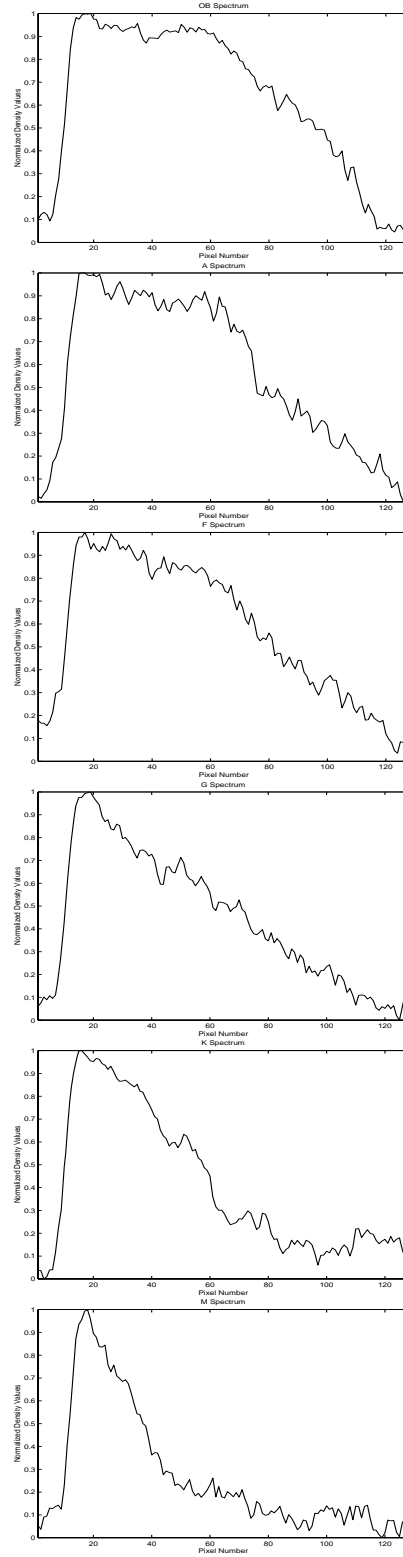


Figure 3: Characteristic stellar spectra (OB, A, F, G, K, M)

4. Classification by use of ANN

An artificial neural network (ANN) of three layers and 72 input units, 32 hidden units and 6 output units has been chosen here. The input units are normalized pixel value units with pixel positions from 11 to 82 corresponding to the central part of digitized spectra. The output units are units corresponding to the six different classes of low-dispersion stellar spectra (OB, A, F, G, K, M). The O and B stars present one class, the OB.

The back propagation learning procedure has been used with a training mode in which the network learns to associate inputs and desired outputs which are repeatedly presented to it (supervised learning) and a verification mode in which the network simply responds to new patterns according to prior training. The experimental database consisted of 426 digitized spectra. This allowed as to initialize, update and train the ANN (Bratsolis 2005). The training procedure is given in figure 4.

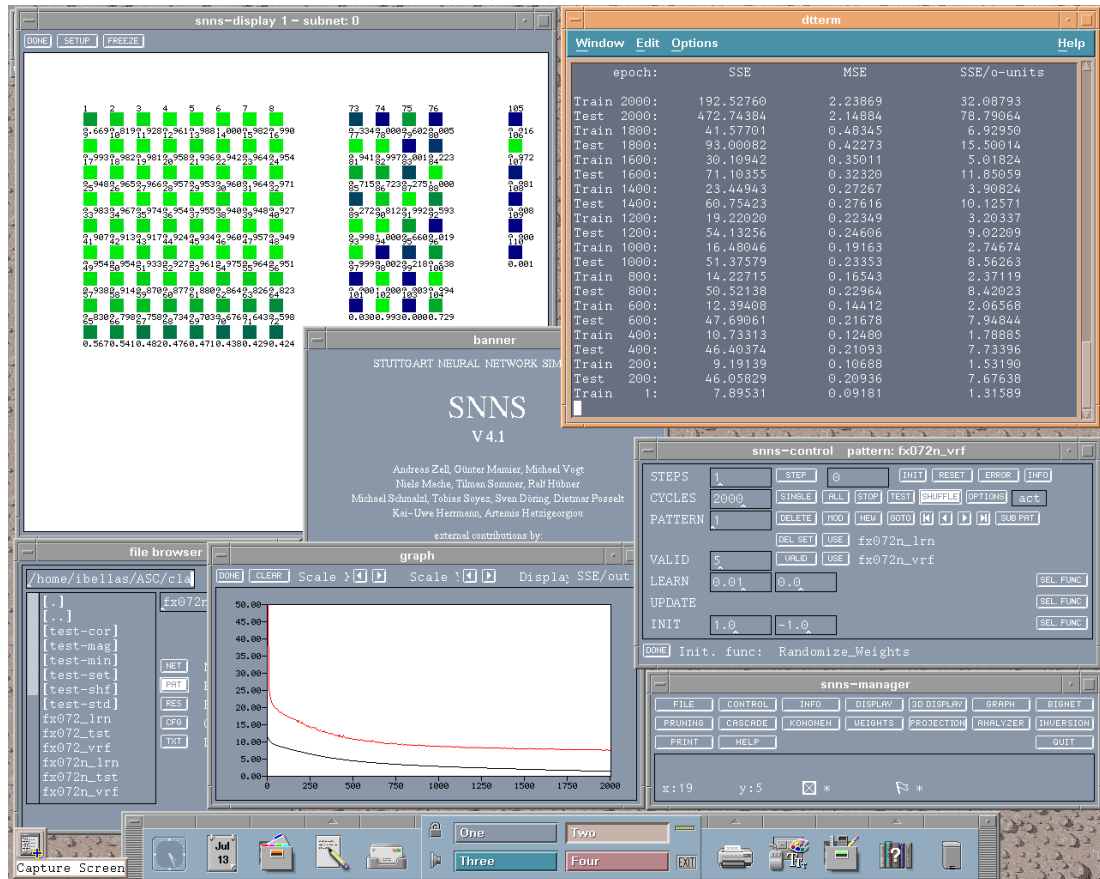


Figure 4: Training of ANN (72 input units, 32 hidden units and 6 output units)

5. Automated classification for the OB stars

The automated method gives the positions of stars for every class. Example for the OB stars is given in figure 5.

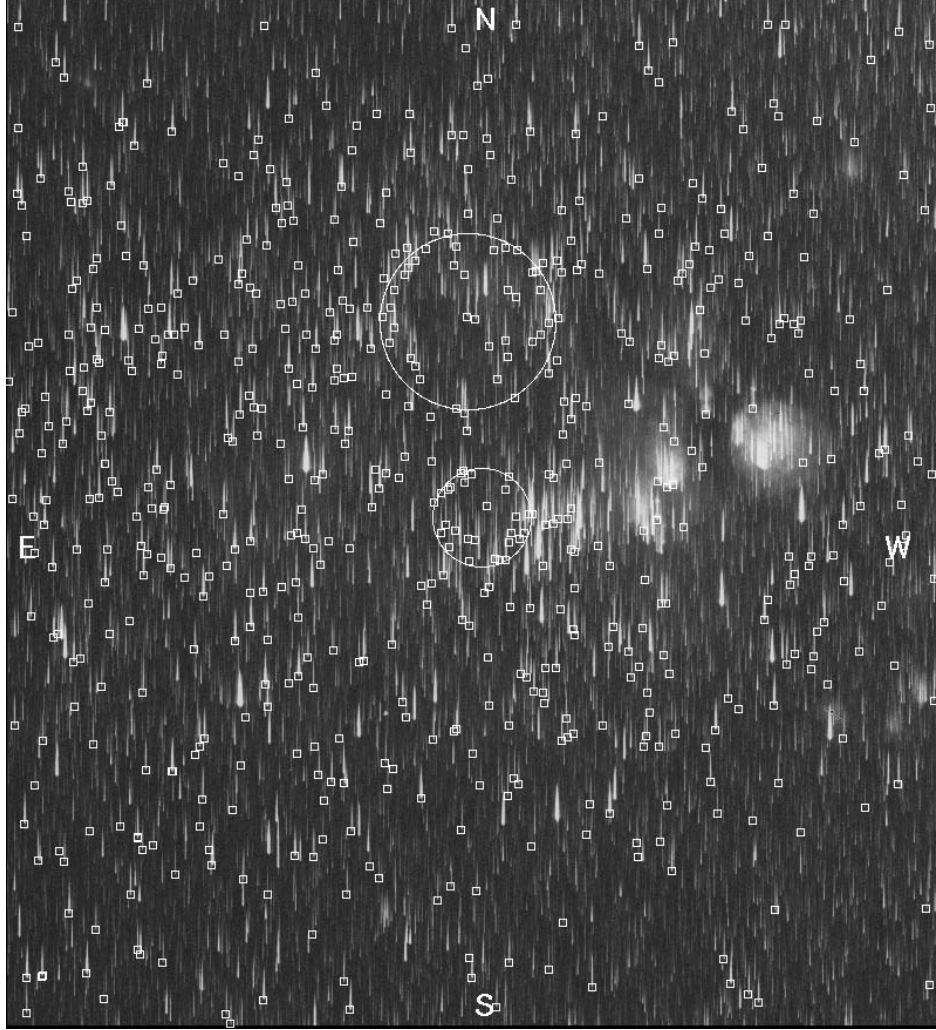


Figure 5: Positions of OB classified stars with automated method. The circles present the regions of SN explosions

The interstellar medium is continuously stirred by supernova explosions and stellar winds. The shock waves engaged by the supernova, accelerate galactic cosmic rays that penetrate deeply into molecular clouds and clumps and both heat and ionize them. Far ultraviolet photons are produced by massive star formation and photoionize the less dense surface regions of the molecular cloud and its internal clumps (Bolatto et al. 2003; Bratsolis et al. 2004; Hatzidimitriou et al. 2005).

6. Conclusions

We have chosen the region N83-84-85 of the inner wing of SMC and we detected all the non-saturated OB stars, from an objective prism plate of this region. We have extracted and classified the stars automatically, using a method developed previously by us. The spatial distribution of the OB stars was found non uniform with holes and high density parts, that could be explained as star formation regions caused by supernovas.

7. References

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