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QUANTITATIVE SPECTRAL CLASSIFICATION. ANALYSIS OF K-M GIANT STARS IN THE VISIBLE AND NEAR-IR REGION

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The absolute magnitude M_V and the color B-V are recovered for a set of 220 K-M stars through two independent ways: A function fitting which involves linear polynomials and artificial neural networks (ANN). In both cases, similar results are found.

1. INTRODUCTION

Quantitative classification of stellar spectra intends to achieve the attainment of physical stellar parameters for a big number of stars. Traditionally, this attainment has been limited to automated MK criteria (Sharpless 1956; Bouw 1981, Kirkpatrick et al 1991; Mayulto et al. 1997) or defining indexes based on measurable features in the spectra which allow the derivation of physical parameters of the stars: Diaz et al. (1989), Zhou (1991) and Cenarro et al.(2001a), (2001b) and (2002) used the calcium triplet; Malyuto et al. (1997) and Malyuto & Schmidt-Kaler (1999) used a set of three indexes. In a quite different approximation, Stock & Stock (1999), Stock et al. (2000) and Molina & Stock (2004) fit polynomial functions by using pseudo- equivalent widths of spectral features as independent variables. On the other hand, Weaver and Torres-Dodgen (1995) used artificial neural network means to generate a non-linear classification model for A stars. In the present work, polynomial function fittings similar to those of Stock & Stock (1999) are made, but in the visible and near IR region of the spectrum with the aim of recovering absolute magnitudes and B-V colors of later stars. With the same data, a non-linear ANN model is generated to recover the same physical parameters. Lastly, both method are compared.

2. DATABASE

The spectra of the 220 stars belong to the library reported by Valdés et al. (2004). Most of these spectra were used by Molina & Stock (2004) to obtain the physical parameters. We focused our attention in the region from 5400 Å to 9500 Å. The absolute magnitudes and color (B-V) are taken from the Hipparcos Catalogue (ESA 1997) and the sample is restricted to those stars with parallax error $\sigma_{p_x}/p_x \leq 20$ %. Since these stars are relatively close to the sun, their interstellar reddening effect does not alter those parameters. The magnitude-color diagram is shown in figure 1. From this figure, it is noticed that the number of K and M dwarf stars is relatively low. For this reason, their analysis in this work is discarded.

3. PHYSICAL PARAMETERS

1) By Function Fitting. As a first step of this work, the absolute magnitude M_V and the color (B-V) are recovered from a set of empirical calibrations which involves linear polynomials. The method followed is described by Stock & Stock (1999). The total EWs measurements and the best ten solutions for the linear polynomials with three independent variables, as well as further explanations, can be seen on the website `http://www.unet.edu.ve/lfac/exactas.html`.

2) By Artificial Neural Networks. The backpropagation algorithm (Rumelhart et al. 1986) is used. In the learning phase, two separated samples of the spectra under study were selected: the first contains the EWs of each component of the CaII triplet and the triplet considered as a whole, with measures for 205 stars, and the second sample contains the EWs of the seven absorption features measured in 113 stars. For both samples, an architecture is designed with topologies of the forms [4:5:3] and [7:5:3], respectively. The first sample provides 51 stars for the training. In the testing phase, the EWs of 113 stars are selected from the first sample and 62 from the second one, which are completely different to those selected in the learning phase. This data permits to prove that both neural network topologies designed can make the desired associations while using input vectors that have never been found during the training phase. This process gives us a measure of the neural network generalization. The standard deviations for the physical parameters in both

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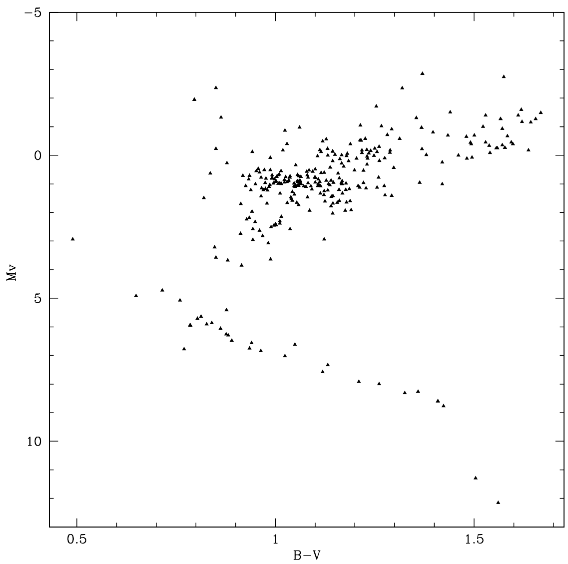

Fig. 1. Magnitude-color Diagram.

topologies can be seen in the web site above mentioned.

4. CONCLUSIONS

1) All these seven features are sensitive to both parameters, 2) ANN is as good as polynomial fittings to recover absolute magnitude and B-V from pseudo equivalent widths of spectral features and 3) ANN is easier to be implemented because of its lack of functions.

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