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DERIVATION OF STELLAR PARAMETERS USING A GRID OF SYNTHETIC SPECTRA

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RESUMEN. Se construyó una red de espectros sintéticos en la región espectral λλ4780 - 5300 A para un conjunto de parámetros estelares. Se seleccionaron y midieron índices espectrofotométricos en esta región del espectro sintético; se compararon estos índices teóricos con aquellos medidos en el espectro observado, para obtener la temperatura de los parámetros estelares, gravedad y metalicidad.

Abstract. A grid of synthetic spectra is built, for a set of stellar parameters, in the spectral region λλ 4780 - 5300 A. Spectrophotometric indices in this region are chosen and measured in the synthetic spectra; these theoretical indices are directly compared to those measured in the observed spectra, in order to obtain the stellar parameters temperature, gravity and metallicity.

Key words: STARS-ABUNDANCES — STARS-ATMOSPHERES — STARS-TEMPERATURES

I. Introduction

The study of stellar populations in the Galaxy involves surveys of large numbers of stars, at different distances in a selected direction. A review on the stellar counts and selected directions is given, for example, by Bahcall (1986).

Deep photometric surveys are available: one example is the Basel survey, which uses RGU photographic broad band photometry, reaching V ~ 18.5 mag (Becker, 1965; Bahcall et al., 1985). Low resolution spectral surveys, reaching magnitudes around V ~ 17 mag were also done in the recent years - see Gilmore (1989) for a review. In this latter case, a library of reference spectra is used, in order to classify the observed stars. This is generally done with the aid of a library of observed spectra (e.g., Gilmore and Reid, 1983; Gilmore, 1989).

In this work we present a library of synthetic spectra, built with the purpose of classifying stars in a way as automatic as possible. The method is applied to low resolution spectra obtained for stars of the SA-141 sample of the Basel survey.

II. Description of the grid

The list of atomic and molecular lines used in the calculations of synthetic spectra, as well as details of the computations are given in Barbuy (1989), Barbuy et al. (1989). The model atmospheres employed are interpolated in the grid by Bell et al. (1976). The set of stellar parameters selected, which are within the following values:

$$4500 \leq T_{eff} \leq 6250\ \mathrm{K}\ ;\ 4.5 \leq \log g \leq 0.5\ ;\ -2.25 \leq |M/H| \leq 0.0$$

were based on isochrones by Vandenberg and Bell (1985).

Microturbulent velocities of 1.0, 1.8 and 2.5 km s^{-1} were adopted for log g = 4.5, 2.0 ≤ log g ≤ 4.5 and log g ≤ 2.0, respectively.

A final grid of 722 synthetic spectra was obtained. The initial calculations were done in steps of 0.02 A. This flux was convolved with a gaussian of FWHM = 0.5 A, and the number of points kept is 1/10 that of the original calculations. This final grid of fluxes is available in (i) VAX format, (ii) binary access direct format.

III. The method for stellar classification

A study of suitable indices was done, in order to check which are the spectral regions more sensitive to temperature, gravity and metallicity respectively. By index we mean

$$\text{Index} = \frac{1}{N} \sum_{i=1}^{N} F_\lambda(\text{local pseudo-continuum}) - F_\lambda(\text{spectrum}) / F_\lambda(\text{local pseudo-continuum})$$

where N is the number of flux points. The spectrophotometric indices chosen are shown in figure 1, and given in table I. Pseudo-continuum points are assumed to be defined by the fluxes at c_1 = 4818, c_2 = 4897 and c_3 = 5290.7 A. In summary, Hβ is a temperature indicator, metallic lines in regions relatively free of molecular lines are metallicity-temperature indicators (indices IM1 - IM5) and regions containing MgH lines (indices IG1 - IG3) are gravity indicators. In particular, the Mg_2 index as defined by Burstein et al. (1984) is our IG2 index.

The selection of model parameters is done by comparing the indices measured in the observed spectrum, to the theoretical ones, within 2 or 3 σ of the noise in the observed spectrum.

From this first set of selected models, the euclidian distance (Thévenin and Foy, 1983) between observed and theoretical spectra is done, as follows

$$d^2 = \sum_{i=1}^{M} (\text{Index}_{\text{synthetic}} - \text{Index}_{\text{observed}})^2$$

where M is the number of indices.

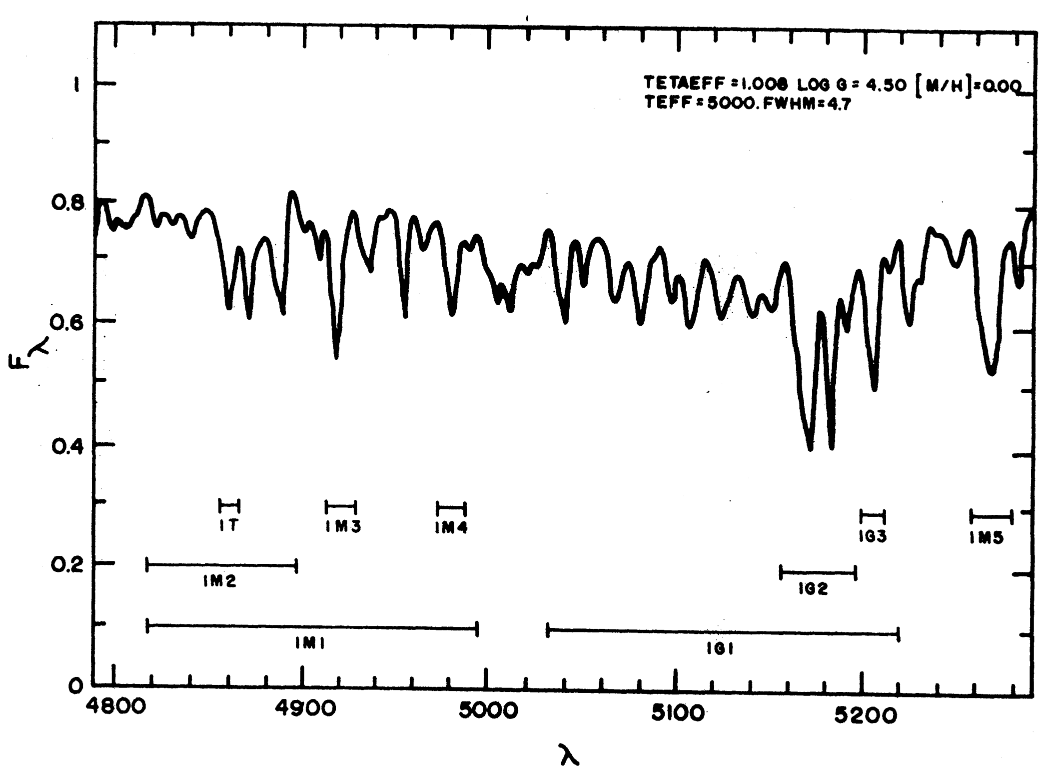

Figure 1 - A typical synthetic spectrum, where the spectrophotometric indices adopted are indicated

IV. Application to observations

The observations were carried out at the 2.2m telescope of the European Southern Observatory (ESO), La Silla, Chile. A CCD was used as detector and the resolution obtained was 4.7 A. The method of stellar classification is applied here to a sample of stars for which the model parameters are known from detailed analyses. The application to about 40 stars shows that the method is satisfactory.

Table I - Spectrophotometric indices adopted

Index	$\Delta\lambda$(Å)	Features
IT	4856. – 4866.	H_β
IM1	4818. – 4996.	atomic lines, H_β
IM2	4818. – 4897.	atomic lines, H_β
IM3	4914. – 4930.	FeI, FeII
IM4	4975. – 4989.	FeI
IM5	5258. – 5279.	FeI, CaI, TiI, CrI, FeII, TiII
IG1	5032. – 5220.	Mg b, MgH, C_2
IG2	5156. – 5197.	Mg_2
IG3	5200. – 5212.	MgH(0,0)

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