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 es-
pectral $\lambda\lambda4780 - 5300$ 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 pa-
rameters, in the spectral region $\lambda\lambda 4780 - 5300$ 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 tempera-
ture, 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 se-
lected 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 $V \sim 18.5$ mag (Becker, 1965; Bahcall et al.,
1985). Low resolution spectral surveys, reaching magnitudes around $V \sim 17$ mag were also done
in the recent years — see Gilmore (1989) for a review. In this latter case, a library of refe-
rence 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 spec-
tra, as well as details of the computations are given in Barbay (1989), Barbay 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:

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

were based on isochrones by Vandenbergh 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 $\leq \log g \leq 4.5$ and $\log g \leq 2.0$, 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 num-
ber of points kept is 1/10 that of the original calculations. This final grid of fluxes is a-
vailable 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

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

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 $c_3 = 5290.7$ Å. 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 Mg2 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 Å. 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

<table>
<thead>
<tr>
<th>Index</th>
<th>Δλ(Å)</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>IT</td>
<td>4856. - 4866.</td>
<td>H₂</td>
</tr>
<tr>
<td>IM1</td>
<td>4818. - 4906.</td>
<td>atomic lines, H₂</td>
</tr>
<tr>
<td>IM2</td>
<td>4818. - 4807.</td>
<td>atomic lines, H₂</td>
</tr>
<tr>
<td>IM3</td>
<td>4914. - 4930.</td>
<td>FeI, FeII</td>
</tr>
<tr>
<td>IM4</td>
<td>4975. - 4989.</td>
<td>FeI</td>
</tr>
<tr>
<td>IM5</td>
<td>5258. - 5279.</td>
<td>FeI, CaI, TiI, CrI, FeII, TiII</td>
</tr>
<tr>
<td>IG1</td>
<td>5032. - 5220.</td>
<td>Mg b, MgH, C₂</td>
</tr>
<tr>
<td>IG2</td>
<td>5156. - 5197.</td>
<td>Mg��</td>
</tr>
<tr>
<td>IG3</td>
<td>5200. - 5212.</td>
<td>MgH(0,0)</td>
</tr>
</tbody>
</table>

References

Becker, W.: 1965, Z. Astrophysik 62, 54

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