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A NEW THEORETICAL LIBRARY OF HIGH-RESOLUTION STELLAR SPECTRA FOR UV-OPTICAL POPULATION SYNTHESIS MODELS

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RESUMEN

Presentamos una nueva biblioteca teórica de espectros estelares que abarca el intervalo de longitud de onda desde 850 a 7000 Å. La biblioteca consiste de dos conjuntos de datos, uno de los cuales incluye la región UV y azul, entre 850 to 4750 Å con una resolución espectral recíproca $R = 50\,000$, y el otro que abarca el intervalo 3500-7000 Å con $R = 500\,000$. Ambos conjuntos están basados en la serie de programas SYNTHE desarrollados por R.L. Kurucz. Debido al gran intervalo de parámetros físicos abarcados (i.e. T_{eff}, $\log g$ y [M/H]), y a la alta resolución espectral, esta biblioteca es la más avanzada disponible actualmente y puede emplearse para estudios de síntesis de poblaciones estelares y para estudios de abundancias químicas de estrellas individuales.

ABSTRACT

We present a new theoretical library of stellar spectra covering the wavelength interval from 850 to 7000 Å. The library consists of two datasets, one including the far UV-blue spectral region from 850 to 4750 Å at inverse spectral resolution $R = 50\,000$, and the latter spanning the range 3500-7000 Å at $R = 500\,000$. Both sets are based on the SYNTHE series of codes developed by R.L. Kurucz. For its comprehensive range of physical parameters (i.e. T_{eff}, $\log g$ and [M/H]) and higher spectral resolution, this is the most advanced spectral library currently available in the literature, and could profitably be used for population synthesis models and abundance studies of single stars.

Key Words: **STARS: ATMOSPHERES**

1. INTRODUCTION

Over the past decade, population synthesis models have become one of the most popular tools to tackle evolutionary properties of stellar systems through the study of their integrated spectral energy distribution (SED) (Buzzoni 1989; Bruzual & Charlot 1993; Worthey 1994). Better facilities and multiwavelength observations have led the synthesis approach to evolve into a highly sophisticated technique trying to account for all major sources of emission and absorption within a galaxy, including dust and gas, along the radio, IR, and even X-ray wavelength range (e.g. Silva, Granato & Bressan 2001).

Two basic ingredients are required to a fair modelling of galaxy SED, namely a stellar library and a set of evolutionary tracks used to build up isochrones. Both these elements have been subject to recent major advances; in particular, the endeavour to overcome long-standing drawbacks in empirical and theoretical stellar libraries is now releasing its profits. On the one hand, the empirical spectral samples have achieved a more complete coverage of the atmosphere parameters (that is effective temperature, surface gravity and chemical composition, e.g. Sánchez-Blázquez et al., this conference). On the other hand, theoretical libraries have also been greatly refined with the inclusion of more reliable chemical opacities in order to better account for the most important molecular and atomic species in the synthetic spectra.

This paper is part of such a latter theoretical effort, and we would like to present here a progress report of our work aimed at constructing the most extended theoretical library currently available at high spectral resolution.

2. THE GRID OF SYNTHETIC SPECTRA

In order to compute a synthetic stellar spectrum one needs a parent model that provides the structure of the atmosphere and describes quantitatively how physical quantities vary throughout the atmospheric layers. This should be coupled with a line list that provides the opacity information of, in the ideal case, all important absorbers within the atmosphere. Our calculations are based on Kurucz model atmospheres and the series of codes SYNTHE (Kurucz 1993 and later upgrades) that solve the radiative and convective transport equations over 72 atmospheric layers ($-7 \leq \log \tau_{\rm ROSS} \leq 2$). Convective equilibrium calculations are based on the mixing length theory with $l/H = 1.25$ for models cooler than 8000 K. The opacity of more than 46 million atomic and molecular transitions has been included.

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TABLE 1

MAIN DISTINCTIVE FEATURES OF THE SPECTRAL LIBRARY

	UV grid	Optical grid
$T_{\rm eff}$	$3\,000 - 50\,000$ K	$4\,000 - 50\,000$ K
$[M/H]$	$-1.5, -0.5, 0.0, 0.5$	$-3.0, -2.0, -1.0, -0.3, 0.0, 0.3$
$\log g$	$1.0 - 5.0$ dex, at steps of 0.5 dex	$0.0 - 5.0$ dex, at steps of 1.0 dex
Wavelength range	$850 - 4\,750$ Å	$3\,500 - 7\,000$ Å
Inverse resolution, $R = \lambda/\Delta\lambda$	50 000	500 000
Number of spectra	1000	832
λ points	70 000	350 000

We have computed two sets of theoretical SEDs covering the ultraviolet (Rodriguez-Merino 2002) and optical (Bertone 2001) wavelength intervals. The two grids were computed independently and, as a consequence, they slightly differ in some characteristics, as summarized in Table 1. Unlike previous theoretical grids (Chavez, Malagnini & Morossi 1997 and references therein), present spectra fully include chemical opacity from the TiO molecule (Schwenke 1998), that has proven to dominate the SED of cool stars in the optical region.

Different resolutions in the visible and UV were selected upon the maximum resolution achievable with current spectrographs on large ground-based telescopes and space facilities. This ensures a direct application of our models both to abundance analyses of galactic stars and to spectrophotometric studies of extragalactic systems, as well.

An entry of our grid is plotted in Figure 1, where we display a comparison of a high-resolution spectrum before and after degradation in resolution (lower panel) with a SDSS red galaxy spectrum, as indicated in the figure. Sky surveys such as SLOAN make mandatory the access to stellar libraries with a complete and homogeneous coverage of stellar types at an increased resolution.

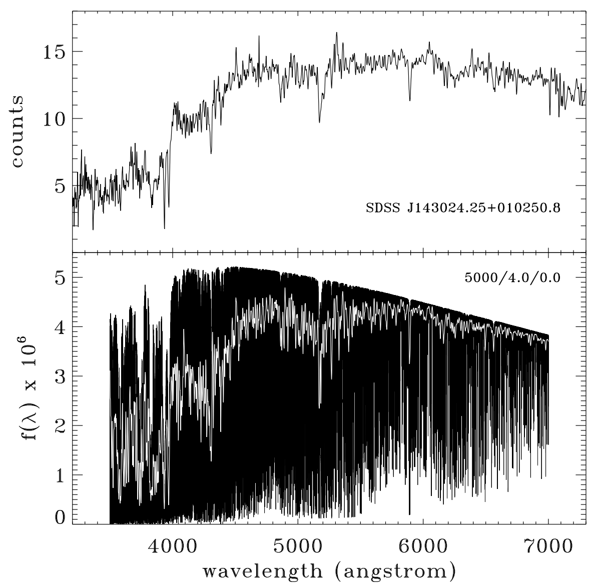

Fig. 1. Upper panel: restframe spectrum of the red galaxy SDSS J143024.25+010250.8 (redshift $z = 0.1903$) from the Sloan Digital Sky Survey (Strauss et al. 2002), smoothed to an inverse resolution $R = 1000$. Lower panel: synthetic high-resolution spectrum of a star with $(T_{\rm eff}, \log g, [M/H]) = (5000$ K$, 4.0$ dex$, 0.0)$. The $R = 1000$ broadened curve is plotted in white over the original $R = 500\,000$ spectrum.

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