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A new stellar library in the K band for the empirical calibration of the CO index

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Abstract. Here we present the results of an observational program aimed at providing a stellar library in the K band with an appropriate coverage of physical stellar parameters (effective temperature, gravity and metallicity) to be used for stellar population synthesis models. In particular, we study the behavior of the CO feature at 2.3 μm as a function of the stellar parameters and we will compute empirical fitting functions that can be easily implemented into stellar population models to provide accurate predictions for integrated CO strengths that will help to face outstanding problems in galaxy formation and evolution.

Keywords. instrumentation: spectrograph – infrared: stars – atlases: stars, fundamental parameters – galaxies: stellar content

1. The new stellar library

Up to date, several authors have already compiled, for different purposes, small libraries in the K band (Johnson & Mendez (1970), Kleinmann & Hall (1986), Lançon & Rocca-Volmerange (1992), Ali *et al.* (1995), Hanson *et al.* (1996), Wallace & Hinkle (1997)). Due to the high S/N ratio of their spectra, it is interesting to highlight the library of Kleinmann & Hall (1986), which contains 26 stars, with a spectral resolution R$\sim$ 2700, and Wallace & Hinkle (1997) who continued extending the previous library. However, both works concentrate exclusively on stars with solar metallicity. Recently, Ivanov *et al.* (2004) presented a larger library comprising the infrared spectra of 218 late type stars at R$\sim 2000-3000$, spanning a range of [Fe/H] from -2.2 to $+0.3$, but these stars have not been flux calibrated.

Here we present a new stellar library that comprises 225 stars observed during 13 nights with R $\sim$ 2500, using Ω-CASS, the near-infrared spectrograph at the 3.5 m telescope in the Calar Alto Observatory (Almería, Spain), and a few control stars observed again with NICS at the Telescopio Nazionale Galileo at El Roque de los Muchachos Observartory (La Palma, Spain). The observed sample is a subset of the MILES optical library presented by Sánchez-Blázquez *et al.* (2006), which contains stars with accurately determined atmospheric stellar parameters by Cenarro *et al.* (2007). The final parameter coverage is: $2800 < T_{\rm eff} < 13400$ K, 0.00 dex $\leqslant \log g \leqslant 5.3$ dex, -2.63 dex $\leqslant$ [Fe/H] $\leqslant 1.33$ dex.

With the aim of understanding the dependence of the CO feature at 2.3 microns on the stellar atmospheric parameters ($T_{\rm eff}$, $\log g$ and [Fe/H]), the stars in the new stellar library have been selected to improve the stellar parameter coverage of previous libraries. In Fig. 1, we present a comparison between the parameter space of our new set of stars

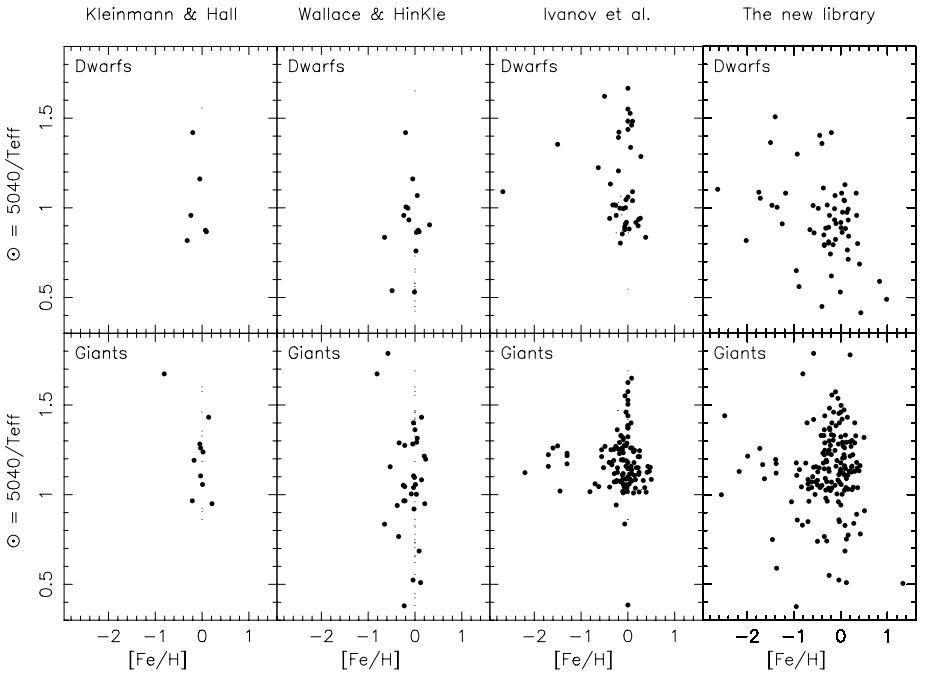

Figure 1. Comparison of the new K band stellar library with the previous public spectral libraries published by Kleinmann & Hall (1986), Wallace & Hinkle (1997), and Ivanov *et al.* (2004). Stars have been represented in two groups (dwarfs and giants; upper and lower panels, respectively). It is clear from this comparison that the new library exhibits a much better coverage of the atmospheric stellar parameters, especially in metallicity, for both giants and dwarfs.

and those of the main previous libraries at this spectral range. It is worth noting the coverage improvement at the low metallicity regime, as well as for warm and very cold stars. This allows us to compute accurate, empirical fitting functions for the CO index all over the parameter space, the ones will be implemented into an evolutionary, single stellar population synthesis model (Vazdekis *et al.* in preparation) to predict the strength of the integrated CO index for stellar populations different ages and metallicities.

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