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Caveats about measuring carbon abundances in stars using the CH band

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Abstract

Context. Stellar carbon abundances are crucial for tracing the star formation history and predicting the near-infrared emission of galaxies. However, deriving accurate carbon abundance estimates for a wide variety of stars is still complex due to the difficulties in properly measuring it from atomic and molecular lines. Therefore, its inclusion in stellar population models remains challenging.

Aims. The aim of this paper is to analyse the carbon abundance determination for the large empirical X-shooter Spectral Library (XSL), commonly used as a benchmark for the development of stellar population models.

Methods. The carbon abundance analysis was performed over strong molecular CH bands in the G-band region. We used the GAUGUIN automated spectrum synthesis code, and adopted two different grids of reference synthetic spectra separately, each with the same [C/Fe] abundance coverage. We carried out a detailed comparison between both grids to evaluate the accuracy and the model dependence of the measured [C/Fe] abundances.

Results. We obtained a large and precise unbiased [C/Fe] abundance catalogue (200 stars) from both theoretical grids, well distributed in the Hertzsprung-Russell (HR) diagram and with no trend with the stellar parameters. We also measured compatible values from each independent CH band, with a high-quality [C/Fe] abundance estimate for both dwarfs and giants indistinctly. We always observed a dispersed flat trend around [C/Fe] 0.0 dex all along the covered metallicity regime (-2.5 < [Fe/H] < +0.5 dex), in agreement with some literature studies. However, we reported variations up to |Δ[C/Fe]| 0.8 dex in the [C/Fe] composition of the star depending on the adopted grid. We did not find such differences in the -element measurements. This behaviour implies a strong model dependence in the [C/Fe] abundance estimate.

Conclusions. Potential sources of error could be associated with the use of spectral synthesis methods to derive stellar carbon abundances in the CH 4300 Å band. Intrinsic small differences in the synthetic models over this crowded and blended region may induce a large disparity in the precise abundance estimate for any stellar type, leading to inaccurate carbon measurements without being noticed.

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