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Developing Automated Spectral Analysis Tools for Interstellar Features Extraction to Support Construction of the 3D ISM Map

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Abstract. One of the ways to obtain a detailed 3D ISM map is by gathering interstellar (IS) absorption data toward widely distributed background target stars at known distances (line-of-sight/LOS data). The radial and angular evolution of the LOS measurements allow the inference of the ISM spatial distribution. For a better spatial resolution, one needs a large number of the LOS data. It requires building fast tools to measure IS absorption. One of the tools is a global analysis that fit two different diffuse interstellar bands (DIBs) simultaneously. We derived the equivalent width (EW) ratio of the two DIBs recorded in each spectrum of target stars. The ratio variability can be used to study IS environmental conditions or to detect DIB family.

Keywords. ISM: structure, abundances, extinction, bands

1. Introduction

To construct a detailed 3D ISM map through the LOS data requires building automated tools to measure the IS absorption features (Vergely *et al.* 2010, Lallement, *et al.* 2014). The tools must disentangle the stellar continuum and all features presented in the observed spectrum. In principle, the spectrum is fitted by a combination of polynomial function or synthetic stellar model, IS profile model, and telluric transmission model (see Puspitarini *et al.* 2013, Puspitarini *et al.* 2015, Chen *et al.* 2013, Monreal-Ibero & Lallement 2017).

2. Method, Data, and Analysis

One of the spectral analysis tools is global analysis to fit simultaneously different IS tracers with multi-fitting functions while linking some of the parameters (Puspitarini *et al.* 2015). We applied the tool to extract diffuse interstellar bands (DIBs). Despite their unknown carriers, they are a promising tool to trace IS cloud, in particular at large distance as they are not easily saturated. We show here the two-DIBs global analysis in late-type star spectra. During the fit, radial velocities of the two DIBs are linked, but remain a free parameter.

We applied the tool to 12 target stars from Gaia-ESO-Survey (GES)/UVES spectra (Gilmore *et al.* 2012) in $(l, b \simeq 213°, -2°)$ and $(l, b \simeq 37°, -7°)$ fields. When the tool were applied to measure narrow and broad DIBs, 6614 and 6283 Å resp. (Fig. 1), the two fields differ in terms of EW ratios. It can be explained by the effect of radiation field that may destroy or favor the DIB carrier(s) (Vos *et al.* 2011). When we applied to a strong and weak DIBs, 6614 and 6196 Å resp., they do not show significant systematic difference between the fields. It confirms that the two DIBs might originate from the same carrier

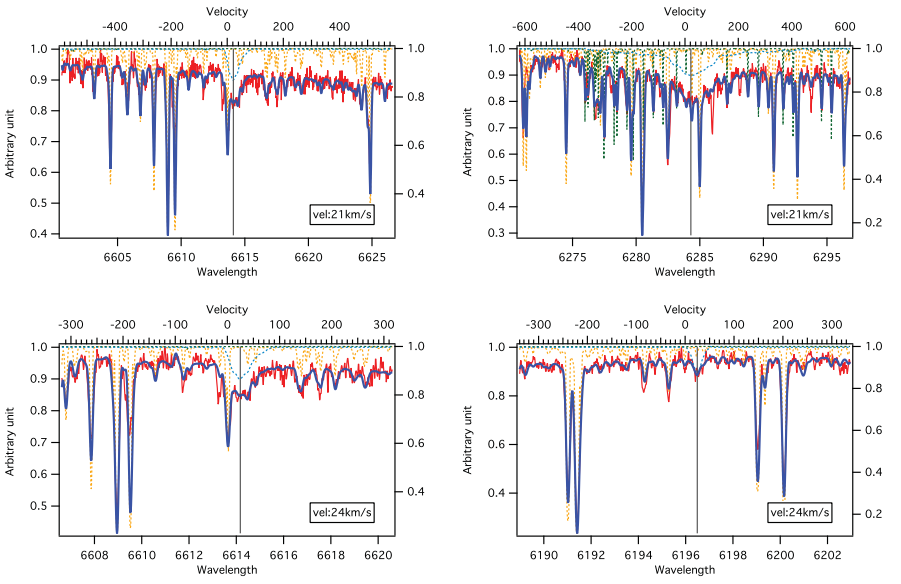

Figure 1. Upper: An example of the global analysis: the 6614 Å DIB (left) and 6283 Å DIB (right). Each spectrum is fitted by a combination of synthetic stellar model, DIB model, and telluric transmission model. The thick line shows the fitting. Models are in dotted lines. Vertical lines show the IS radial velocity (v_r) which is linked. The global analysis helps constraining v_r for a very wide DIB from a narrower DIB. **Lower:** Same as upper figure, but for the 6614Å DIB (left) and 6196 Å DIB (right). The method helps detecting a weaker DIB (6196 Å) from the constraint on its radial velocity that is linked to a stronger DIB (6614Å).

(family of DIBs). The global analysis allows to understand relationship between the two DIBs and to derive their kinematic at the same time. The EW ratio can be used to study IS environmental conditions or to detect DIB family. The global analysis method can also be a strong advantage for DIB detection.

3. Discussions and Future Works

We have briefly discussed the principle of the tools and shown the two-DIBs global analysis. The EW measurements will increase the LOS data for the 3D ISM map. The EW can be converted into A_0 by using the EW-A_0 relationship with caution. Together with precise stellar distances from Gaia, these can be used to infer ISM distribution. We will improve and apply the tools to more datasets, e.g., GES, Bosscha Compact Spectrograph spectra (Malasan *et al.* 2001), etc.

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