Extractions automatisées des bandes diffuses des spectres d'étoiles froides

Chen Hui-Chen[1], Lallement R.[1], Puspitarini L.[1], Babusiaux C.[1], Bonifacio P.[1] , Hill V. [2]

[1]GEPI (UMR9111), Observatoire de Paris, Universit Paris-Diderot, 5 Place Jules Janssen, 92190, Meudon France

[2] Laboratoire Lagrange (UMR7293), Universit de Nice Sophia Antipolis, CNRS, Observatoire de la Cte d'Azur, BP 4229, 06304, Nice Cedex 4

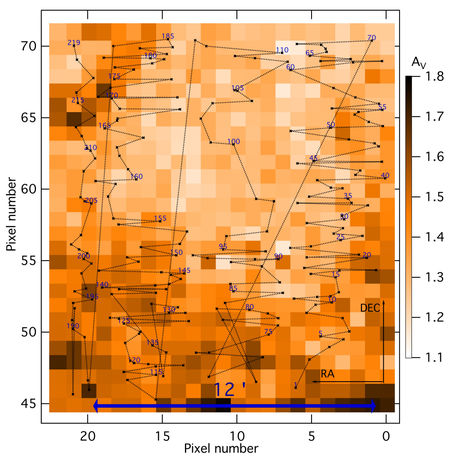
hui-chen.chen@obspm.fr, ,

Summary

We have developed a new automatic method to extract the diffuse interstellar bands (DIBs) from the cool star spectra. Unlike the previous methods for hot stars, which treat the stellar continua as a polynomial function, this method includes the stellar synthetic model for each star independently. The telluric lines are also considered by adopting atmospheric transmission synthetic models.

The first approach we have done is on the Baade's Window with 219 red clump giants. Three DIBs at 6196.0, 6204.5, and 6283.8 Å are measured. The uncertainties are smaller in the strong DIB 6283.8 Å and are larger in the other two weaker DIBs. The correlations between DIBs and the OGLE extinction (Sumi 2004) are clearly seen although the variability exists from DIB to DIB.

Data

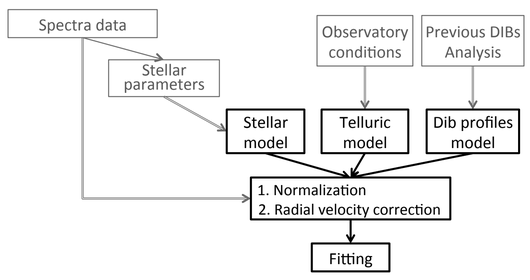


We have used 219 bulge read clump giants in the Baade's Window (l =0.8, b =-4). Those stars have been observed with FLAMES/GIRAFFE at the VLT in the GIRAFFE HR13 setup, with a resolution of R=22500 and the wavelength from 6120 to 6405 Å. The stellar parameters we adopted here are derived by Hill et al. (2010). The figure in the left shows the distribution of the stars in the field labelled in numbers. The color scale is in the extinction measured by Sumi 2004.

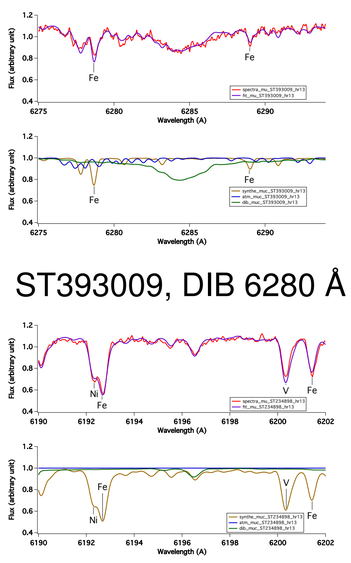
Fitting Method

In the fitting, we considered three components together described below. The fitting process is shown in the flowchart.

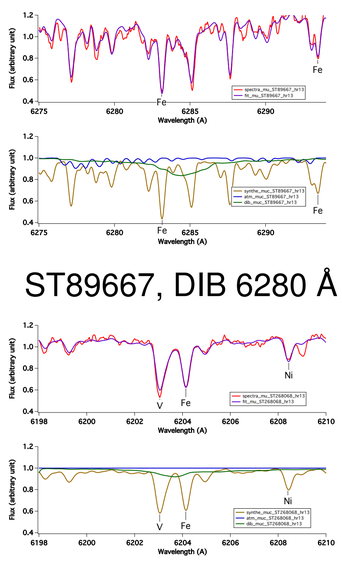
- Stellar model: ATLAS 9 + SYNTHE (Kurucz 2005). Effective temperature, gravity, micro-turbulence and metallicity are considered.
- DIB profile: from the FEROS spectra, derived by Raimond et al. (2012) and Puspitarini et al. (2012).



- Telluric model: LBLRTM code (Line-By-Line Radiative Transfer Model, Clough et al 2005), the molecular database HITRAN (HIgh-Resolution TRANsmission molecular absorption, Rothman et al. 2009).



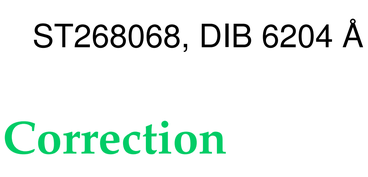
ST393009, DIB 6280 Å



ST89667, DIB 6280 Å

In the left are a few examples of the fitting results. For DIB 6283.8 Å, the spectra are well fitted while without or with stellar line contaminations.

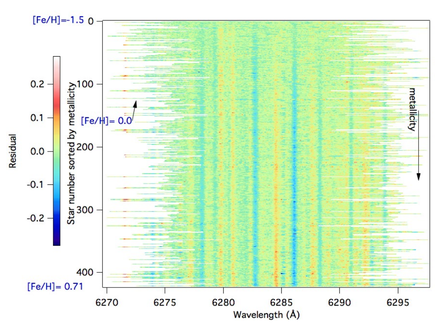
ST234898, DIB 6196 Å

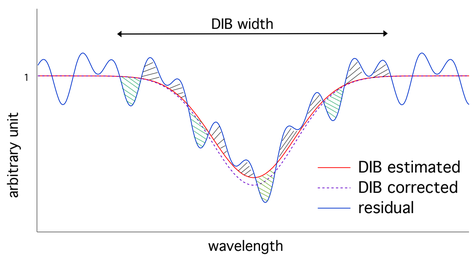


ST268068, DIB 6204 Å

For the weaker DIBs, 6196.0 and 6204.5 Å, the results are more effected by the accuracy of the stellar models. Hence the uncertainties are larger.

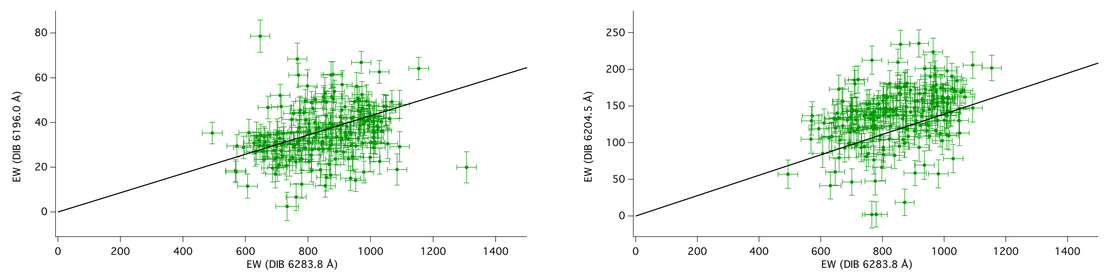
Equivalent Width Correction





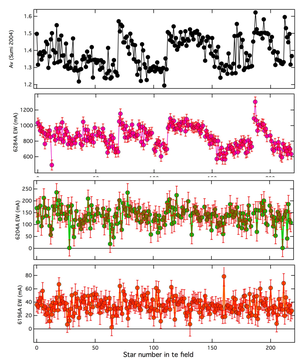
From the fitting, we derived the equivalent width (EW) for three DIBs. Some stellar lines are systematically over- or under- predicted, or even missing. The upper left figure shows the residual (data-model) from the results for the DIB 6283.8 Å. It appears that the residual is correlated with the metallicity. Thus have used this correlation to build and apply an empirical correction.

DIB-DIB Correlation

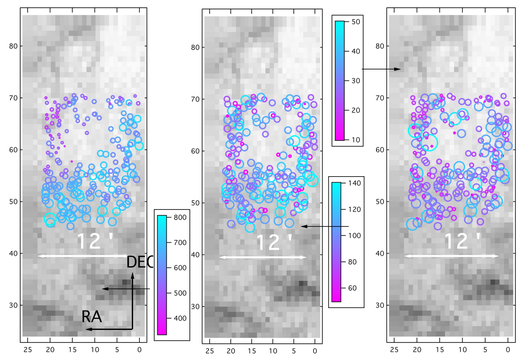


The upper two figures show the EWs for DIBs 6196.0 and 6204.5 Å as a function of the stronger DIB 6283.8 Å. The EWs for the three DIBs are measured independently, despite the large uncertainties for the two smaller DIBs, the correlations between each two of them are clearly visible.

DIB-Extinction Correlation



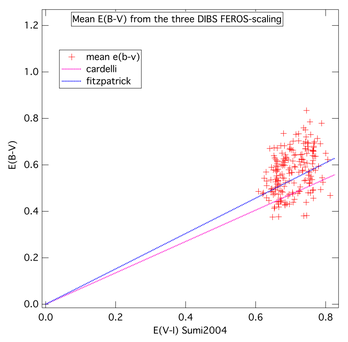
The left figure indicates the extinction (interpolated from Sumi 2004, OGLE data), and the EWs derived from the three DIBs as a function of the star number, from top to down, respectively. There are similarities in the extinction and the EWs of DIBs. However, the similarity is better in DIB 6283.8 Å and weaker in the other two DIBs.



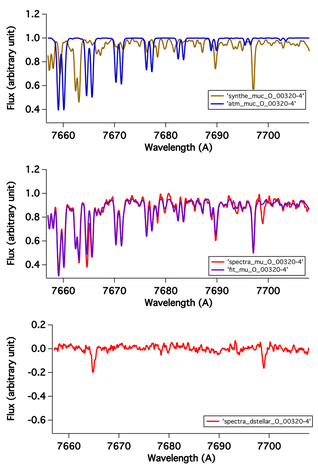
The three panels in the right show the ratio (by the circle sizes) between the EWs derived from the three DIBs to the extinction value interpolated from Sumi 2004. The superimposed grey scale is the extinction value. From left to right are figures for 6283.8, 6204.5, and 6196.0 Å DIBs, respectively.

The ratio for DIB 6196.0 Å is quite homogenous through the field, while the ratios for the other two DIBs show the spatial variabilities. This may due to the intrinsic DIB variations in response to the radiation field or may be related to spatial variability of the extinction curve.

Figure at right shows the mean value of E_{B-V} derived from the three DIBs compared with the E_{V-I} derived from the OGLE data (Sumi 2004). The red and blue lines show two established relationships between E_{B-V} and E_{V-I} from two different works. It allows us to conclude that the three DIBs can be used as the first estimator for the reddening.



KI Line Extraction



The figure at left shows an example of the KI line extraction in cool star spectra. The KI doublet is located in a spectral region that is strongly contaminated by telluric oxygen lines. Like for the DIBs extraction, we fit data with both stellar synthetic model and telluric synthetic transmission. The residual is the KI doublet. The next step will be the adjustment of a combination of the stellar, telluric and doublet models.

References

1. Chen Hui-Chen, et al, 2012, A&A, accepted.
2. Hill et al. 2011, A&A, 534, A80
3. Kurucz, R. L. 2005, Memorie della Società Astronomica Italiana Supplementi, 8, 14
4. Raimond S., et al, 2012, A&A, 544, 136
5. Sumi, T. 2004, , 349, 193

PCMI, Paris, 19-21 Novembre 2012