THE DIFFUSE INTERSTELLAR BAND AT 8620 Å: A GOOD REDDENING TRACER FOR GAIA

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Abstract. We report about a surprisingly good correlation between the equivalent width of the diffuse interstellar band (DIB) at 8620 Å and the interstellar reddening. Such a correlation offers bright prospects in using the 8620 Å DIB as a tracer of the extinction through the Galaxy in the context of the GAIA mission by ESA.

The GAIA mission planned by ESA is aimed to provide astrometry in the 10 microarcsec regime and multiband photometry for all stars down to mag 20. The mission Red Book prepared by ESA plans GAIA to host a spectrograph to measure radial velocities and therefore to provide the 6th component of the phase-space coordinates for all stars brighter than V~16 (the exact limit will be set by final optical design, spacecraft scanning law, global throughput and S/N threshold to trigger the detection during crossing of the focal plane, dimensions of the latter, on-board data analysis and telemetry rate, etc.). In the current GAIA design as base-lined in the Red Book, the spectroscopic observations will be carried out over the 8500-8750 Å region at \( \lambda/\Delta\lambda = 20,000 \) resolving power (corresponding to 0.25 Å/pix and a 2 pix FWHM in the PSF sense).

The astrophysical outlines of the GAIA mission are discussed by Gilmore et al. (1998) and an outlook of the GAIA payload and spacecraft is presented by Mérat et al. (1999). The goals of GAIA spectroscopy and the performance of the 8500-8750 Å region are discussed by Munari (1999). Atlases of real and synthetic spectra in this region at the resolution base-lined for GAIA may be found in Munari & Tomasella (1999) and Munari & Castelli (2000).

No ion abundant in the interstellar space has resonant lines in the 8500-8750 Å. There are however some Diffuse Interstellar Bands (DIBs). The strongest one is at \( \lambda \) 8620 Å. It has been so far very poorly studied in literature. An example of the band from real spectra secured with the Asiago Echelle spectrograph is offered in Figure 1.

Given the extreme high accuracy of the astrometry and photometry carried out by GAIA (distances accurate to 10% at 10 kpc at V=15 mag, photometry accurate to 0.001 mag for the majority of the 10th target stars), a measure of the DIBs in the 8500-8750 Å by the on-board spectrograph could provide an accurate 3-D map of the distribution...
Figure 1: Comparison between un-reddened and a moderately reddened early A-type supergiants (HD 197345 and HD 223385, respectively). The strongest stellar absorption lines and the diffuse interstellar band at 8620 Å are identified (adapted from Munari & Tomasella 1999).
Figure 2: Correlation between the equivalent width of the diffuse interstellar band at 8620 Å and the reddening for stars widely spread in galactic coordinates and distance from the Sun (adapted from Munari 1999 and Munari et al. 1999).
of the DIB carriers along any line of sight in the Galaxy (and the nearby dwarf satellite
galaxies which brightest stars will be reachable by GAIA).

A topic of the highest relevance is a proper handling of the reddening while reduc-
ing and interpreting the GAIA observations. Will the measure of the DIBs be of any
assistance in this matter? It obviously depends on if a relation between reddening (here
written as $E_{B-V}$) and some DIB-related quantity (like the equivalent width ($EW$) or
the central depth) exists and how tight is the correlation. DIBs in the optical range
have been generally reported to correlate poorly with reddening. In There may be really
a problem with some DIBs, but in other cases it is quite possible that systematic obser-
vation errors, a naive approach to data handling or even the use of a wrong extinction
law for a given direction in the Galaxy have artificially resulted in an apparently poor
correlation.

Munari (1999) has shown how a relation exist between $EW$ and $E_{B-V}$ for the 8620 Å
DIB, that was calibrated as $E_{B-V} = 2.63 \times EW(Å)$ on the base of 11 stars observed with
the Asiago Echelle spectrograph. In the meantime Munari et al. (2000) have continued
the observations and expanded the sample to 37 stars widely distributed in galactic
coordinates and distances. The result from this enlarged sample is (see Figure 2)

$$E_{B-V} = 2.69 \times EW(Å)$$

which nicely confirms the earlier results. The tight correlation shown in Figure 2 defini-
tively proves the utility of the 8620 Å DIB as a reddening tracer and meter, even at low
reddening values. However, the exact slope of the relation can be expected to depend
upon the properties of the interstellar material, which change with galactic coordinates
and with distance along a given line of sight. Therefore, the most general relation would
take the form

$$E_{B-V} = \alpha(l, b, D) \times EW(Å)$$

The fine-grid calibration of $\alpha(l, b, D)$ will be performed by GAIA itself. In the mean-
time, we are carrying out additional observations that will be discussed by Munari et
al. (1999; see also Moro & Zwitter in these Proceedings), to derive $\alpha(l, b, D)$ along
selected lines of sight in the Galaxy, to the specific aim to investigate if the relation
of Figure 2 (the mean over many different line of sights) will sharpen further when
applied to narrower and narrower $l, b$ cones, which will make it more and more useful
as a reddening meter.

References

Gilmore G., Perryman M., Lindegren L. Favata F., Hoeg E., Lattanzi M., Luri X.,
Harbig G.H., 1995, ARA&A 33, 19
Merat P., Safa F., Camus J.P., Pace O., Perryman M.A.C. 1999, in Proc. of the
ESA Leiden Workshop on GAIA, 23-27 Nov 1998, Baltic Astronomy, 8, 1
Munari U., 1999, in Proc. of the ESA Leiden Workshop on GAIA,
23-27 Nov 1998, Baltic Astronomy, 8, 73
Munari U., Castelli F., 2000, A&AS 141, 141