REDDENING CORRECTION FROM THE 2175 Å DUST ABSORPTION FEATURE

0Based on INES data from the IUE satellite
ILLEANA GÓMEZ
LAEFF-INTA, ESAC. E-28691 Villanueva de la Cañada, Madrid (Spain)
CARMEN MORALES
LAEFF-INTA, ESAC. E-28691 Villanueva de la Cañada, Madrid (Spain)
ANGELO CASSATELLA
INAF-IFSI, Via del Fosso del Cavaliere 100, 00133 Roma (Italy)
ENRIQUE SOLANO
LAEFF-INTA, ESAC. E-28691 Villanueva de la Cañada, Madrid (Spain)

Abstract: Two methods are presented allowing for a precise determination of the reddening correction from the 2175 Å dust feature in ultraviolet spectra[1]. Applications to the Virtual Observatory and WSO projects are highlighted.

Keywords: Interstellar Medium – Reddening Correction – Ultraviolet – Spectroscopy.

1 Introduction

Some fraction of light from astrophysical sources is absorbed and scattered by interstellar dust particles along the line of sight. This effect, the interstellar extinction, usually measured through the E(B-V) colour excess, is particularly strong in the ultraviolet range, and causes the observed energy distribution to appear redder than emitted.

For stars, the E(B-V) value is readily obtained from the observed colour index B-V and the tabulated values corresponding to their spectral type and luminosity class. Typical errors on E(B-V) values obtained in this way are usually not better than 0.05 mag. This leads to quite large errors on intrinsic fluxes, especially in the UV range (about 18 % at 3000 Å and as much as 51 % at 1300 Å). Alternative non-standard methods applicable to other types of objects as, for example, emission line sources and galaxies are even less accurate. The importance of deriving reliable values of E(B-V) is immediately realized when considering the role of dust absorption in the energy budget of galaxies (in the Galaxy, roughly 30% of the light absorbed in the UV is reemitted in the far infrared). The dramatic effects of interstellar reddening

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are shown in Fig.1, where the UV observed spectrum of the highly reddened star HD 46202 is compared with the corresponding dereddened spectrum. We propose to study and test two methods for the determination of E(B-V) based on the presence of a broad absorption maximum in the ultraviolet range around 2175 Å, both being readily applicable to the Visual Observatory data through simple and effective algorithms, as well to study "ad hoc" filters for reddening determination for the World Space Observatory project.

2 Depth of the 2175 Å band

The first method takes advantage of the fact that the Galactic dust absorption coefficient has the same value around 1700 Å and 2420 Å (see Fig. 1, left–hand panel), so that the flux ratio at these wavelengths is insensitive to E(B-V). The depth, here called "intensity", of the absorption dip at 2175 Å has been so defined:

$$I(2175) = (F^{*}(2175) - F(2175))/\ F^{*}(2175). \quad (1)$$

where $F(2175)$ is the observed flux at 2175 Å, and $F^{*}(2175)$ is the interpolated flux obtained from the linear baseline defined by the observed fluxes at 1700 and 2420 Å.

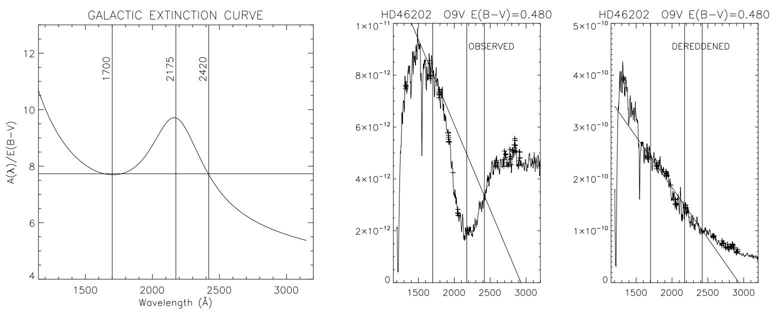

Figure 1: *Left:* Extinction curve in the ultraviolet (Seaton 1979). *Middle:* observed energy distribution of HD46202. *Right:* same after reddening correction.

For a preliminary test, we have measured the intensity of the 2175 Å feature in ≈ 300 stars with known E(B-V) in a wide range of values (0.05 to 0.8). The results are shown in Fig. 2, where the literature values of E(B-V) are plotted as a function of $I(2175)$ together with a linear regression to the data points. The corresponding r.m.s. error on E(B-V) is 0.07 mag, a value that should be possible to reduce significantly through a careful revision of the input literature values of E(B-V), and the quality of the spectra (to verify the presence of any instrumental artifacts).

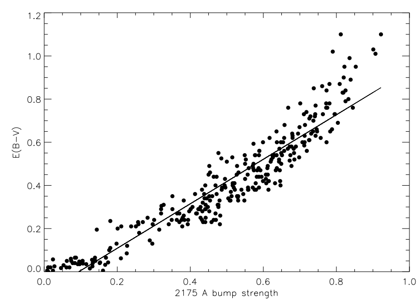

Figure 2: Literature values of E(B-V) as a function of the dust feature intensity for our sample of about 300 stars.

3 Comparison with model atmosphere spectra

The second method consists in comparing a given UV spectrum corrected for different amounts of E(B-V), with a grid of Kurucz [2] models in a wide range of spectral type (for the moment only luminosity class V stars are considered). This provides an error matrix in the $((T_{eff}, E(B-V))$ plane, from which it is possible to evaluate directly the best guess of these parameters i.e. that leading to an error minimum, and then to the model which best fits the data (see Fig. 3). We have applied this method to $\approx$ 150 luminosity V stars belonging to the previous sample. The results are shown in Fig. 3, where the literature values of E(B-V) are plotted as a function of $I(2175)$ together with a linear regression to the data points. The corresponding r.m.s. error on E(B-V) is 0.05 mag.

4 Conclusions

The results so far suggest that the "bump intensity method" is fairly accurate compared with standard methods. Since it does not require any a priori information, but just three flux measurements (at 1700 Å, 2175 Å and 2420 Å), it is equally well applicable to normal and peculiar stars, as well as to composite spectra (e.g. globular clusters or external galaxies). On the other hand, the second method, based on a comparison with model spectra, requires a more laborious process, but it does provide slightly more accurate E(B-V) values. Our next plan is to improve the existing algorithms for an immediate use within the Virtual Observatory project. This will also require to extend the present database to about 500 stars of different spectral type and luminosity class, as well as to a consistent number of representative sources

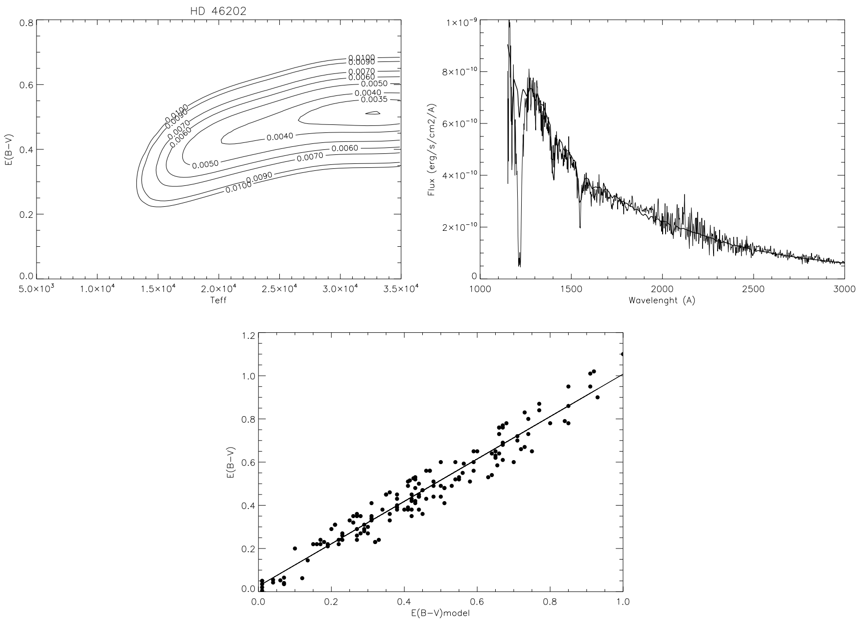

Figure 3: *Left:* Iso–error plot for the O9V star HD46202; it shows that the minimum fitting error occurs at E(B-V) = 0.51 and T_{eff}=32900 K. *Right:* Reddening corrected flux of HD46202 compared with the Kurucz model atmosphere best matching the data. *Bottom:* Literature values of E(B-V) as a function of those obtained from model fitting.

of heterogeneous nature. Note that the "bump intensity method" could have an additional interesting application to the World Space Observatory project. In fact, broad band photometry at the three above wavelengths from UV imaging could provide a direct mean to map dust absorption within the WSO field of view.

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References

[1] Seaton, M. 1979, MNRAS 187, 73
[2] Kurucz, R.L. 1979, ApJS 40,1