

# Interstellar Reddening Determination through the 2200 Å Dust Absorption Band

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**Abstract** A comparison is carried out between two methods to evaluate the correction for interstellar reddening: the three ultraviolet points method, and the traditional model fitting method. The two methods have been applied to a large sample of well known stars of spectral types O, B and A to test their reliability and to assess their general applicability.

## 1 The sample of stars

We present a further study of the two methods for the determination of interstellar reddening described in [3] and expand them to a larger sample of stars of all luminosity classes and spectral types O, B and A. The stars have been selected from the following sources:

- The galactic O star catalog by [5], which provides a reliable spectral classification and reddenings for O stars.
- The IUE Ultraviolet Spectral Atlas by [8], containing a selection of good quality ultraviolet spectra of standard stars observed with IUE and having a reliable MK classification.
- The sample of very reddened stars in [7].
- The catalogue of standard stars from [2], containing stars with a well known MK spectral classification, and

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- The SIMBAD Astronomical Database from the CDS, Strasbourg, France, used to fill the gaps in spectral types or luminosity classes.

From this initial sample, we have selected stars with well known spectral classification and hence  $E(B-V)$ , for which good quality large aperture IUE spectra were available both in the short and long wavelength cameras. A further requirement was that the observations of a given star were taken within the same day. Variable, binary, peculiar and stars with circumstellar envelope were excluded. The ultraviolet spectra of the selected stars were retrieved from the INES database. We have adopted SIMBAD spectral types for B and A-type stars and obtained the  $E(B-V)$  values from the corresponding intrinsic colors as tabulated by [6]. In the case of O stars, we adopted the spectral types and  $E(B-V)$  values in [5].

The final sample fulfilling the above requirements contained 370 stars, 112 O stars, 201 B stars and 105 A stars. For O and B stars the  $E(B-V)$  values cover quite uniformly the range 0 to 1.40 mag. The sample does not contain A-type stars with  $E(B-V)$  larger than 0.4, because this large value strongly limits the observable flux at short wavelengths.

## 2 The three ultraviolet points method

This method is more general than the model fitting method described later, and can in principle be applied to any spectral type and luminosity class. Its main advantage consists in obtaining the  $E(B-V)$  value directly from the observed mean flux in three suitably selected UV bands, without any previous knowledge of the target considered. The central wavelengths of the UV bands are 2175 Å, where dust absorption is maximum, and 1700 Å and 2420 Å. These latter bands, lying at both sides of the dust bump, have been purposely chosen to take advantage of the fact that the Galactic extinction law has the same value at these wavelengths, so that the flux ratio at these two wavelengths does not depend on  $E(B-V)$ .

We apply the method to our sample of 370 stars, and compare the  $E(B-V)$  values deduced from the intensity of the absorption at 2175 Å with those obtained from the observed color ( $B-V$ ) and the intrinsic color corresponding to the spectral type of the stars. The relation found is of the type:

$$E(B-V) = a + b \times \log(D_{2175}) \quad (1)$$

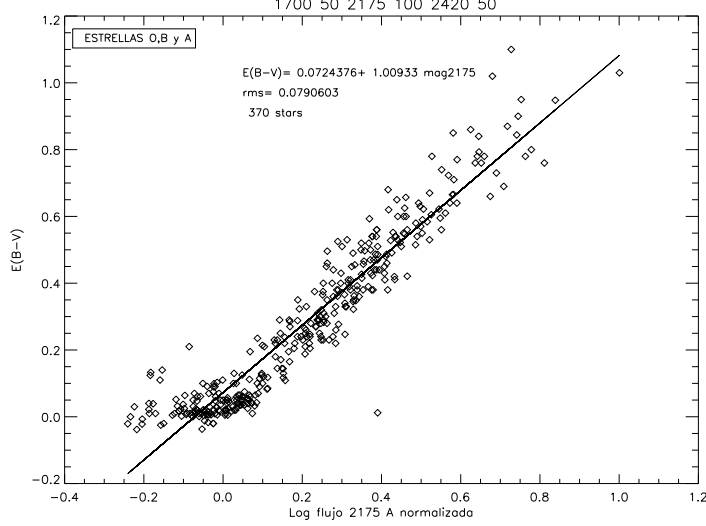
where  $a$  and  $b$  are quantities close to 0 and 1, respectively, and

$$D = F_{2175}^C / F_{2175} \quad (2)$$

is the depth of the dust absorption, being  $F_{2175}^C$  and  $F_{2175}$ , the extrapolated continuum flux, and the measured flux at 2175 Å, respectively

The above equations provide the value of  $E(B-V)$  as a function of the measured depth of the dust absorption feature at 2175 Å. The method does not require any pre-

vious knowledge of the spectral type or luminosity class. However, there are items that deserve further study, as for example the effect of line opacity and of metallicity of the star. Such parameters could in fact bias the determination of the true continuum at the three quoted wavelengths, introducing systematic errors in Eq. 1. This is particularly true for A-type stars, which are especially sensitive to changes in metallicity and luminosity class at UV wavelengths.



**Fig. 1** Relation of  $E(B-V)$  deduced from the spectral type versus  $E(B-V)$  obtained from the intensity of the absorption at 2175 Å.

### 3 Model fitting method

The model fitting method is more accurate than that described above, but can only be applied to normal stars for which model atmosphere spectra are available. The Kurucz grid of theoretical atmosphere models used in this work are from the [4] Library. The  $E(B-V)$  values were obtained through an automatic procedure that fits the observed spectrum to theoretical models in a wide range temperature and reddening values until the best match is obtained. Observed spectra were dereddened using the [1] parametrization. In this preliminary study, we have used models with  $\log g = 4.0$ ,  $v_{turb} = 2.0$ , and solar metallicity, and applied it to a subsample containing 204 normal Main Sequence stars. Extension of the model fitting method to other luminosity classes and metallicity is in progress.

The best fitted model gives directly the  $E(B-V)$ ,  $T_{eff}$  and distance of a star.

## 4 Conclusions

The interstellar extinction law has a well defined bump in the ultraviolet, centered at 2175 Å followed by a steep increase at shorter wavelengths. The 2175 Å bump has been well studied and found its origin in the absorption by dust grains. Different sizes and composition of dust give slightly different bump sizes being its main effect in the different slope of the far ultraviolet part of the extinction law. The precise form and intensity of the 2175 Å interstellar extinction and the steep increase in flux extinction towards the far ultraviolet makes unique the best solution of theoretical model fitting to spectral observations which include this wavelength range. For longer wavelengths the reddened model and the observations are almost flat and the solution could not be unique unless it contains the Balmer jump. But even there, where the Balmer jump defines the temperature, the extinction curve doesn't have a characteristic form there to define precisely the color excess. In a subsequent work we will compare the model fitting results in these two wavelength regions.

In this work we have shown two methods of reddening deduction in the direction of a star without the knowledge of the spectral type, only with a spectral observation in the ultraviolet or with three flux determinations at wavelengths of 1700, 2175 and 2420 Å.

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