1995109421

N95-15836

20077
p. 5

DIFFUSE BANDS VERSUS EXTINCTION PARAMETERS

W. Wegner,* T.P.Snow,** C.Sneden,*** and J.Krełowski,****
* Pedagogical University, Institute of Mathematics, Chodkiewicza 30, 85-064 Bydgoszcz, Poland
** CASA - Campus Box 389, University of Colorado, Boulder, CO 80309, USA
*** Department of Astronomy and McDonald Observatory, University of Texas, Austin, Texas 78712
**** Institute of Astronomy, N. Copernicus University Chopina 12/18, 87-100 Toruń, Poland

1 Sources of analyzed data

We have collected all available recent, high quality measurements of the strong diffuse bands 5780 Å and 5797 Å (in the spectra of 196 stars), derived both from our own measurements (performed with the aid of the McDonald echelle spectograph installed at the 2.1m telescope made during February, May and November of 1993 (for the data ackquiring and reducing procedures see Krełowski and Sneden 1993) as well as with the coudé spectrograph atached to the 3.6m CFH telescope (some preliminary results have already been published by Krełowski *et al.* 1992) and from the literature (Chlewicki et al., 1986, Federman et al. 1984, Herbig 1993, Josafatsson and Snow 1987). Equivalent widths of the diffuse interstellar bands (DIBs) 5780 Å and 5797 Å have been measured on spectrograms of 81 stars ackquired at McDonald and 47 CFHT spectrograms. The measured signal-to-noise ratio (S/N) on own spectrograms ranged from 250 to 500. The measurements of the bands equivalent widths were performed five times to allow error estimates. The standard deviations of single measurement usually do not exceed 5%.

The Johnson UBV data were used to estimate the color excesses of our targets. These data were taken from the catalogues: Blanco et al. (1970), Hoffleit and Jaschek (1982), Nicolet (1978). Spectral types and luminosity classes were taken either from Hoffleit and Jaschek (1982), or from Blanco et al. (1970). The intrinsic values of $(B-V)_0$ were taken from Papaj et al. (1993) whereas the infrared intrinsic colors from Wegner (1994). The infrared magnitudes were taken from Ashok et al. (1984) and from Gezari et al. (1984).

2 Results

Figs. 1 and 2 depict the equivalent widths of 5780 Å and 5797 Å respectively versus E(B-V). The bands' intensities relate quite tightly to E(B-V) with very similar correlation coeffi-

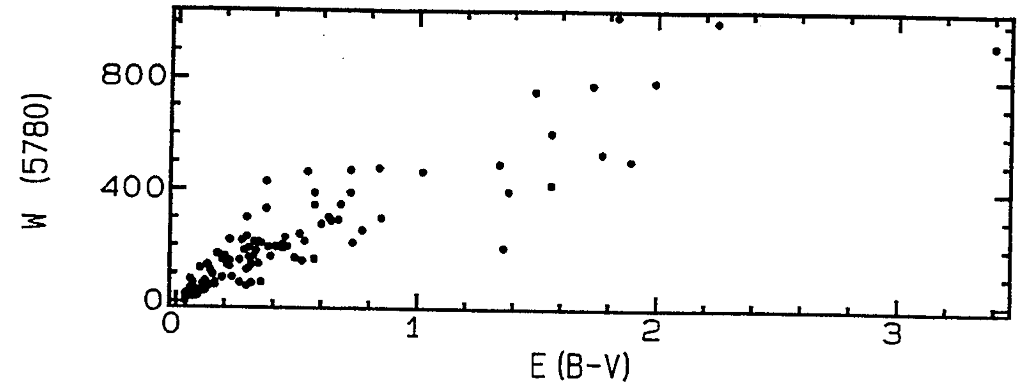

Fig. 1. The dependence of the equivalent width of the 5780 Å DIB upon E(B-V). Note the tight relation in the range E(B-V) $\leq$ 1.0.

cients. However, in the case of 5780 Å diffuse band the relation gets much worse when E(B-V) $\geq$ 1.0.

We received a very interesting result in our sample: in a part of spectra belonging, in accordance to **The Bright Star Catalogue** Hoffleit and Jaschek (1982) to the class of Oe or Be objects no $H\alpha$ emission can be traced. Some of these objects clearly show this strong line in emission; some others show also the strong HeI lines near 5876 Å and 6678 Å in emission. In our Figures "normal" stars *i.e.* without any emission lines in our McDonald spectra are marked with dots, the stars with $H\alpha$ in emission are represented as triangles. In our sample twenty stars show the HeI 5876 Å line in emission and these are marked as open circles. Be stars are commonly believed to be shell stars with pretty opaque circumstellar envelopes.

In the spectra of Be stars characterized by both HI and HeI emissions both diffuse bands are very weak with respect to reddenning (Fig. 3 and Fig. 4); (the effect is especially well–seen for E(B-V) $\leq$ 0.2) which suggests a very low abundance of DIB carriers in circumstellar shells. The stars in which only $H\alpha$ emission is observed do not show this anomaly. Diffuse bands are in their spectra as strong in relation to E(B-V) as in "normal" stars *i.e.* without any emission lines.

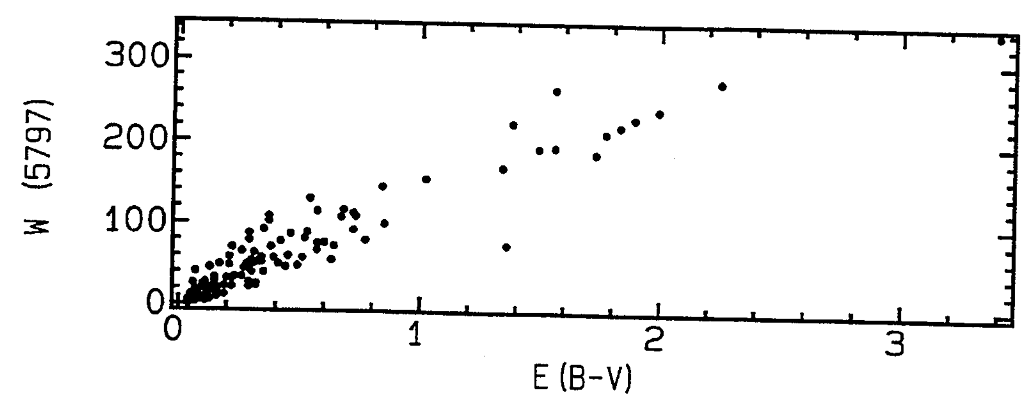

Fig.2. The dependence of the equivalent widths of the 5797 Å DIB upon E(B-V). The relation is just little a bit tighter than that of Fig. 1.

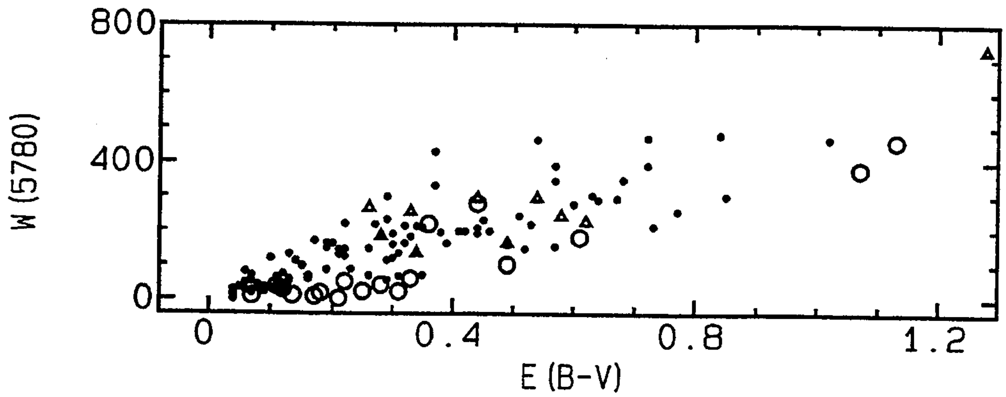

Fig.3. The dependence of the equivalent widths of the 5780 Å DIB upon E(B-V). Dots represent normal OB stars, open circles - OB stars with HeI (5876 Å = D3) and $H\alpha$ emission, triangles - OB stars with only $H\alpha$ emission.

The intensity ratio of the 5797 Å to 5780 Å bands shows strong variations when E(B-V) $\leq$ 1.0; in cases of higher reddenings the ratio converges to a constant value (about 0.32) - see Fig. 5. Apparently it is a long distance average over many interstellar clouds whereas among bright, lightly reddened objects we observe at most only a few clouds along any sightline which makes the ratio deviation–prone.

Also the ratio of E(K-V)/E(B-V), proportional to the ratio of total–to– selective extinction, becomes constant when diffuse bands are strong – Figs. 6 and 7 – which should also be expected in cases of distant objetcs.

The ratio of infrared color excesses happens to be very high in the spectra of slightly reddened Be stars which is probably due to circumstellar infrared emissions. The observed HeI emission lines are apparently connected with opaque circumstellar shells which contain dust grains producing both visual extinction (but of E(B-V) usually not exceeding 0.2) and infrared emissions. These opaque circumstellar matter does not contain DIB carriers and, if such a cloud is situated along any sightline, the observed intensities of diffuse bands are lower in relation to reddening. The effect is not so strong in cases of heavily reddened,

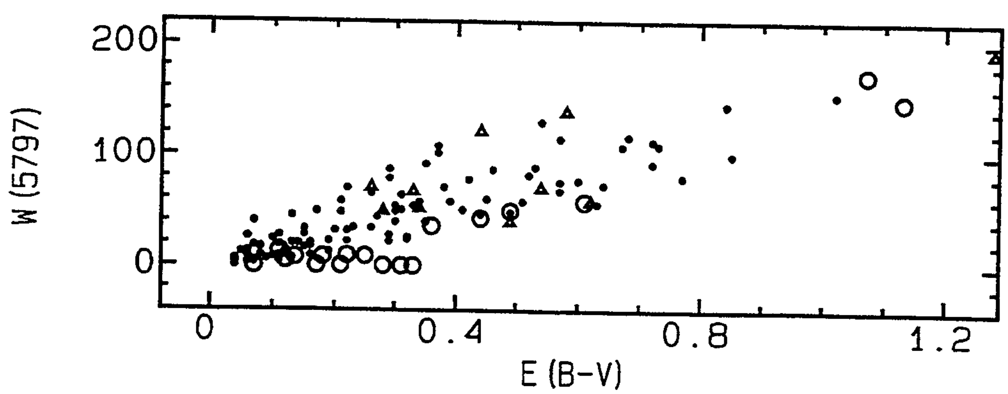

Fig.4. The dependence of the equivalent width of the 5797 Å DIB upon E(B-V). Dots represent OB stars, open circles - OB stars with HeI (5876 Å = D3) and $H\alpha$ emission, triangles - OB stars only with $H\alpha$ emission.

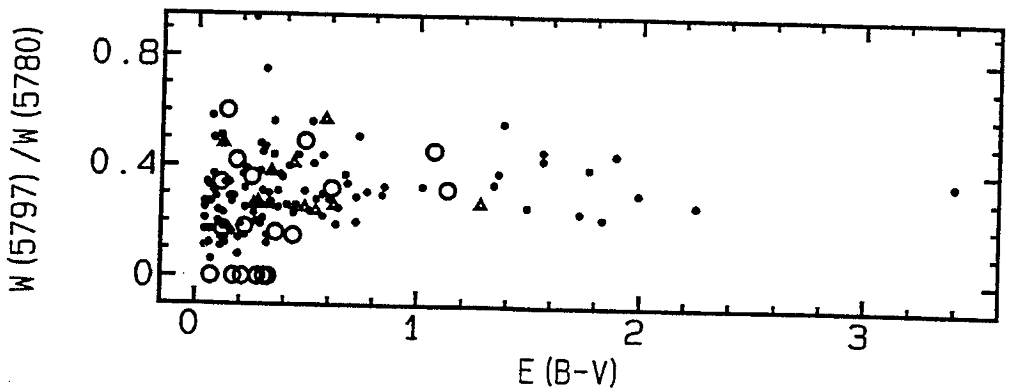

Fig.5. The plot of intensity ratio W(5797)/W(5780) versus E(B-V). Dots represent OB stars, open circles - OB stars with HeI (5876 Å = D3) and $H\alpha$ emission, triangles - OB stars only with $H\alpha$ emission.

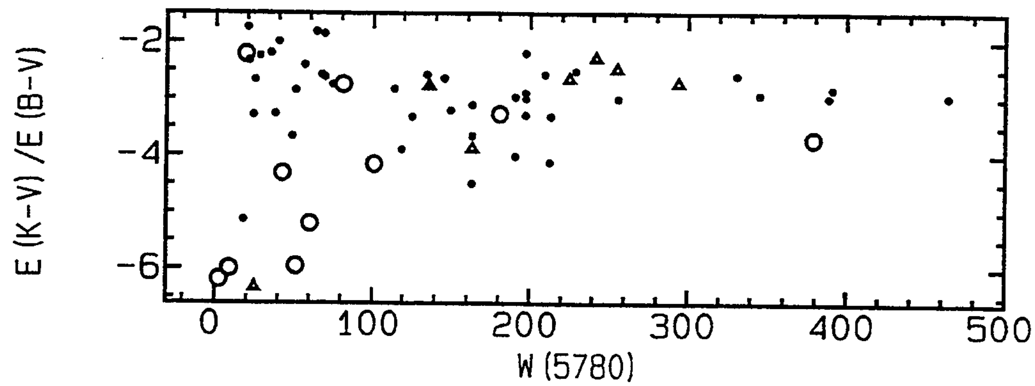

Fig.6. The dependence of the E(K-V)/E(B-V) versus equivalent width of the 5780 Å DIB. Symbols as in Fig. 5.

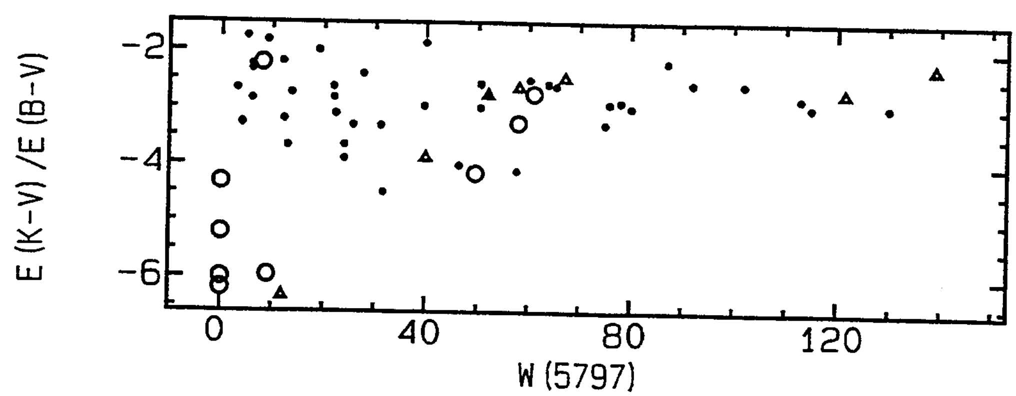

Fig.7. The dependence of the E(K-V)/E(B-V) versus equivalent width of the 5797 Å DIB. Symbols as in Fig. 5.

distant targets due to the growing influence of truly interstellar clouds. It is to be mentioned that the extinction curves derived from the vacuum ultraviolet spectra of the TD–1 satellite by Papaj *et al.* (1991) show strong peculiarities in the cases of the lightly reddened Be stars. The extinction curves in such cases lack the prominent 2200 Å feature which is easily observed in all other cases. This proves that circumstellar grains are evidently different from the truly interstellar ones. In this environment DIB carriers either stick onto the grain surfaces or stick together or they are disrupted by some mechanism, characteristic for the circumstellar shells.

The general conclusion is that in cases of distant, heavily reddened stars, the optical properties of interstellar matter along such sightlines are practically identical. In cases of individual clouds we may, however, expect strong differences. These differences observed in the shape of extinction curve and in the ratio of 5780 Å and 5797 Å intensities clearly reveal differences in physical and chemical structure of interstellar clouds.

3 References

Ashok, N.M., Bhatt, H.C., Kulkarni, P.V., Joshi, S.C.,: 1984, Mon.Not.R.Astr. Soc. 211, 471

Blanco, V.M., Demers, S., Douglass, G.G. FitzGerald, M.P.,: 1970, Publications U.S. Naval Observatory, Second Series, 21

Chlewicki,G., van der Zwet, G.P., van Ijzendoorn,L.J., Greenberg, J.M., and Alvarez, P.P.,: 1986, Astrophys.J., 305, 455

Federman,S.R., Kumar, C.K., and Vanden Bout, P.A.: 1984, Astrophys.J.,282, 485

Gezari, D.Y., Schmitz, M., Mead, J.M.,: 1984, NASA Ref.Publ. 1118

Herbig,G.H.,: 1993, Astrophys.J. 407, 142

Hoffleit, D., Jaschek, C.,: 1982,: The Bright Star Catalogue, Yale University Observatory, New Haven

Josafatsson, K., and Snow, T.P.,: 1987, Astrophys.J., 319, 436

Krełowski, J., Sneden, C.,: 1993, Publ. Astr. Soc. Pacific, 105, 1141

Krełowski, J., Snow, T.P., Papaj, J., Seab, C.G., Wszołek, B.,: 1993, Astrophys. J. 419, 692

Nicolet, B.,: 1978, Astron. Astrophys. Suppl. 34, 1

Papaj, J., Krełowski, J., Wegner, W.,: 1993, Astron. Astrophys. 273, 575

Papaj, J., Krełowski, J., Wegner, W.,: 1991, Mon.Not.R.Astr.Soc. 252, 403

Wegner, W.,: 1994, Mon.Not.R.Astr.Soc. (in press)