PROPERTIES OF INTERSTELLAR DUST IN THE REGION OF THE CEP OB4 ASSOCIATION

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1. Introduction

A number of papers have been devoted to the study of regional variations in the interstellar extinction law (see reviews of Savage and Mathis, 1979; Krelowski, 1986). Among the areas with abnormal interstellar extinction law (IEL) the region of Cyg has been noted by a number of authors (see, e. g., Nandy, 1964; Johnson, 1965; Whiteoak, 1966; Goy, 1972; Wampler, 1962; Sūdžius, 1974). Goy (1972) and Wampler (1962) has pointed out that the IEL for the Cyg OB2 association is characteristic of another association, Cep OB4. However, the investigations of interstellar extinction in this association are very scarce and we lack detailed extinction curve for this region of the sky.

Therefore an attempt was made to study interstellar extinction in the region of the Cep OB4 association. The Vilnius seven colour photometric system has been used for this purpose (Straižys, 1977). The effective wavelengths and their reciprocals for the Vilnius photometric system are presented in Table 1.

Table 1

	U	P	X	Y	Z	V	S
λ_e, Å	3425	3730	4037	4650	5149	5429	6500
$1/\lambda_e$, μm^{-1}	2.92	2.68	2.48	2.15	1.94	1.84	1.54

This system has already been applied for the study of variations in the IEL in four regions ofthe sky: Cyg, Cep, Per and Mon (Sūdžius, 1974). It was shown that the Cyg IEL deviates from that for Cep, Per and Mon regions where the IEL was found to be rather uniform. Therefore an average IEL was derived for Cep, Per and Mon regions. It was also found that the interstellar extinction curve has the so-called very broadband structure (VBS) in the visual part of the spectrum. This structure is surprisingly uniform for all the regions investigated. The results of multicolour photometry were combined with the data of Whiteoak (1966) and detailed interstellar extinction curves were derived for Cyg and for Cep-Per-Mon (average) regions in the wavelengths interval of 3000-8000 Å (Sūdžius, 1974).

2. Observations

For the present study OB stars with known Sp/L types were selected from published data. 10 suitable stars were found in the region of the Cep OB4 association. For comparison 18 stars of the Cyg OB2 association were also observed. The observations were obtained with the 48 cm and 1 m telescopes at the observational site near the Maidanak Mountain in Uzbekistan in 1977 and 1985.

The observational procedure and reduction technique were the same as generally accepted for the Vilnius photometric system (Straižys, 1977).

3. Method

The usual way to study possible variations in the IEL is an analysis of differences of colour excess ratios (E/E), E_{ij}/E_{jk}, for different regions of the sky, where magnitudes j and k indicate the normalization points and i is any other magnitude of the photometric system.

In the Vilnius photometric system magnitudes Y and V are chosen for normalization. Therefore colour excess ratios E_{UY}/E_{YV}, E_{PY}/E_{YV}, E_{XY}/E_{YV}, E_{YZ}/E_{YV} and E_{VS}/E_{YV} are calculated. The colour excesses of the observed stars were determined using intrinsic colour indices ofStraižys et al. (1982) and were plotted on two index diagrams. The E/E were calculated by the method of Williamson (1968) and were normalized to Whitford's (1958) IEL: $A_i=(E_{iY}/E_{YV})E_{YV}^{(n)}+A_Y^{(n)}$. This procedure requires the following values of $E_{YV}^{(n)}=0.23^m$ ($E_{BV}=0.32^m$) and $A_Y^{(n)}=1.26^m$. In order to examine the VBS in the interstellar extinction curve deviations of obtained extinction values from Whitford's (1958) IEL, $\Delta A=A_i-A_i^{(w)}$, were determined. It should be noted that in the interval of wavenumbers from 1 to 3 μm^{-1} Whitford's IEL is represented by two straight lines intersecting at 2.24 μm^{-1}.

4. Analysis

The results of calculation of the E/E and their r.m.s. errors are presented in Table 2. This Table also includes the results for the so-called average IEL (Sūdžius, 1974). The plots of colour

Table 2

Area	$\frac{E_{UY}}{E_{YV}}$	$\frac{E_{PY}}{E_{YV}}$	$\frac{E_{XY}}{E_{YV}}$	$\frac{E_{YZ}}{E_{ZV}}$	$\frac{E_{VS}}{E_{YV}}$
Cep OB4	1.791	1.279	0.849	2.173	0.867
	.006	.005	.004	.019	.003
Cyg OB2	1.746	1.237	0.824	1.779	0.885
	.003	.002	.002	.007	.003
Average	1.608	1.138	0.754	1.797	0.843
(Sūdžius,1974)	.009	.006	.005	.021	.007

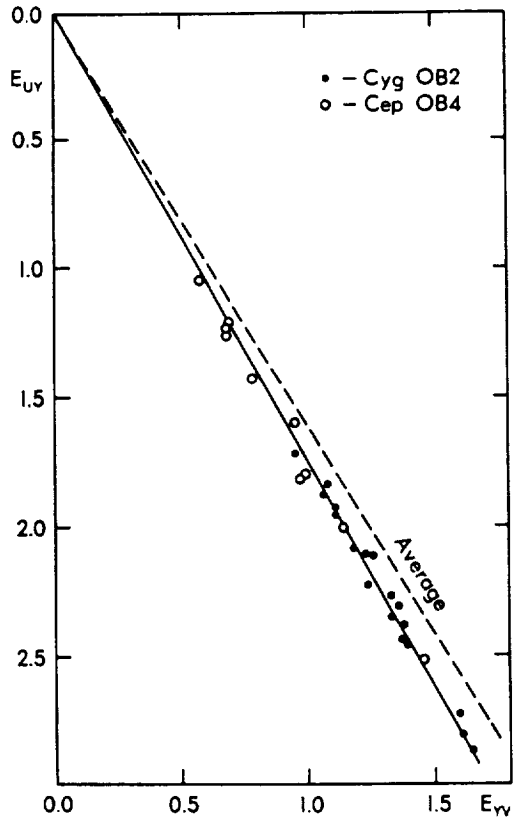

Fig. 1. The diagram E_{UY}, E_{YV} for the observed stars. The continuos line corresponds to the E/E for Cyg OB2 and the dotted one to the average E/E from Sūdžius (1974).

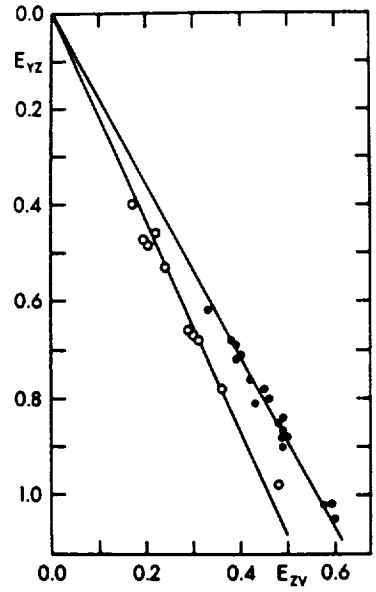

Fig. 2. The diagram E_{YZ}, E_{ZV} for the observed stars. The designations are the same as in Fig. 1.

excesses E_{UY}, E_{YV} and E_{YZ}, E_{ZV} are shown in Figs. 1 and 2 respectively. Pecularities of the IEL are well demonstrated by deviations of the obtained extinction values from those of Whitford's (1958), ΔA. These deviations as well as deviations of the average extinction curve from Whitford's one are plotted in Fig. 3.

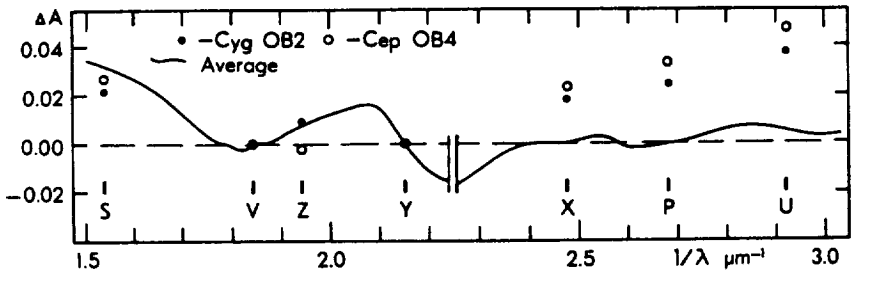

Fig.3. Deviations of Cyg OB2, Cep OB4 and the average extinction laws from Whitford's (1958) one versus wavenumber. The positions of magnitudes of the Vilnius photometric system are indicated.

The obtained results show that in the ultraviolet the IEL for Cep OB4 differs from the average one and is very close to that for Cyg OB2. This conclusion supports the results of Wampler (1962) and Goy (1972) but is in disagreement with the results of Lucke (1980). A little higher values of extinction in the ultraviolet for Cep OB4 in comparison with those for Cyg OB2 confirm the conclusion of Goy (1972). The VBS in the interstellar extinction curve for Cyg OB2 does not differ significantly from the average one and is in agreement with the results of Whiteoak (1966), York (1971), Rex and Hayes (1977) and Krelowski et al. (1986). However, our results indicate that the Cep OB4 extinc-

tion curve probably has no VBS in the interval of wavenumbers 1.84 - 2.15 μm^{-1}. This fact is very important because our results (Sūdžius, 1974) indicate uniformity of the VBS for all the stars investigated.

5. Conclusions

The obtained IEL for the Cep OB4 association does not match any of the laws determined for other regions of the sky. However, it is very close to the Cyg OB2 law in the ultraviolet.

Our results suggest the Cep OB4 IEL to have no VBS in the interval of Wavenumbers 1.84 - 2.15 μm^{-1}.

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