POLARIZATION AND EXTINCTION BY ALIGNED GRAINS

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Abstract. Correlations between ultraviolet extinction and visual polarization are studied. No correlations are found for sampled 272 stars. UV extinction and visual polarization are quite independent phenomena.

1. Introduction

It is well established that wavelength dependence of UV extinction varies from star to star. This variation is usually interpreted as the difference in abundance of grains which characterize the UV extinction (UV grains, hereafter). Other factors, however, may also have effects on this variation. Greenberg and Chlewicki (1987) suggested that the alignment of grains responsible for visual polarization has an effect on UV extinction. In addition, if the UV grains are well aligned, an effect by this alignment may appear in UV extinction, as well as in UV polarization which data is unavailable now (except Gehrels, 1974). The alignment of the UV grains is possible, since the magnetic alignment is more effective for smaller grains (Greenberg, 1978, Seki and Hasegawa, 1986).

Wealth of data provides an opportunity to look for possible correlations between visual polarization and UV extinction. In the present paper, we select the stars for which both visual polarization and UV extinction data are available, and investigate their correlations.

2. Data

Data of visual polarization are cited from Axon and Ellis (1976), and those of UV extinction are from Savage et al (1985) who used results of the Astronomical Netherlands Satellite (ANS). The stars are selected which are well reddened (E(B-V) > 0.4 mag), but those are rejected showing UV variability, lying in a cluster, or being identified as double. Thereby we get the sample of 272 stars.

Polarization efficiency $p_v/E(B-V)$ of these stars ranges from 0 to around 10 percent/mag. As is shown in Figure 1,

$p_V/E(B-V)$ increases with l in the range of l = $50° - 140°$ (l:galactic longitude). This is not inconsistent with the direction of magnetic field being in $l = 50°$ (e.g. Spitzer 1978). Thus the large spread of $p_V/E(B-V)$ in the present sample is mainly due to the difference in angle between the direction of the magnetic field and that of the line of sight.
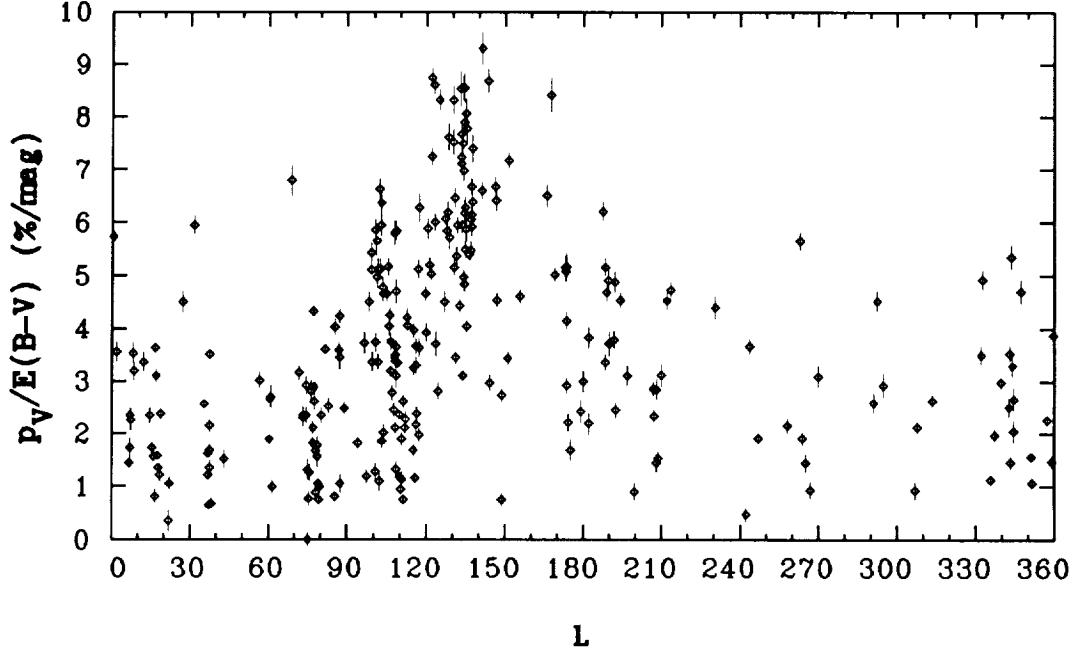

Figure 1. Dependence of $p_V/E(B-V)$ on galactic longitude.

3. Results and Suggestions

Figure 2 shows dependence of the normalized UV color excess $E(\lambda-V)/E(B-V)$ on the optical polarization efficiency $p_V/E(B-V)$, for $\lambda = 3300$, 2200, and 1550 A. It is apparent that $E(\lambda-V)/E(B-V)$ does not correlate with $p_V/E(B-V)$. Similar results are obtained for $\lambda = 2500$ and 1800 A. Correlation coefficients are very small: -0.03, 0.09, 0.26, 0.10, and 0.12 for λ = 3300, 2500, 2200, 1800, and 1550 A, respectively. We can safely say that no significant correlations are found.

To get more quantitative information, we divide the sample into four groups according to the value of $p_V/E(B-V)$, and calculate mean and standard deviation of $E(\lambda-V)/E(B-V)$ in each group (Table 1). The means of $E(\lambda-V)/E(B-V)$ are fairly constant against $p_V/E(B-V)$, especially for $\lambda = 3300$ and 2500 A. Though the model

calculation predicts that the value of $E(\lambda-V)/E(B-V)$ decreases by around 0.5 as $p_V/E(B-V)$ increases from 0 to 9 percent/mag (Greenberg and Chlewicki, 1987), we cannot find such variation in our sample. This may imply that the grains responsible for visual polarization do not have significant contribution to UV extinction. Otherwise, they may be poorly aligned, with their polarization efficiencies being quite high (e.g. magnetite proposed by Shapiro, 1975).
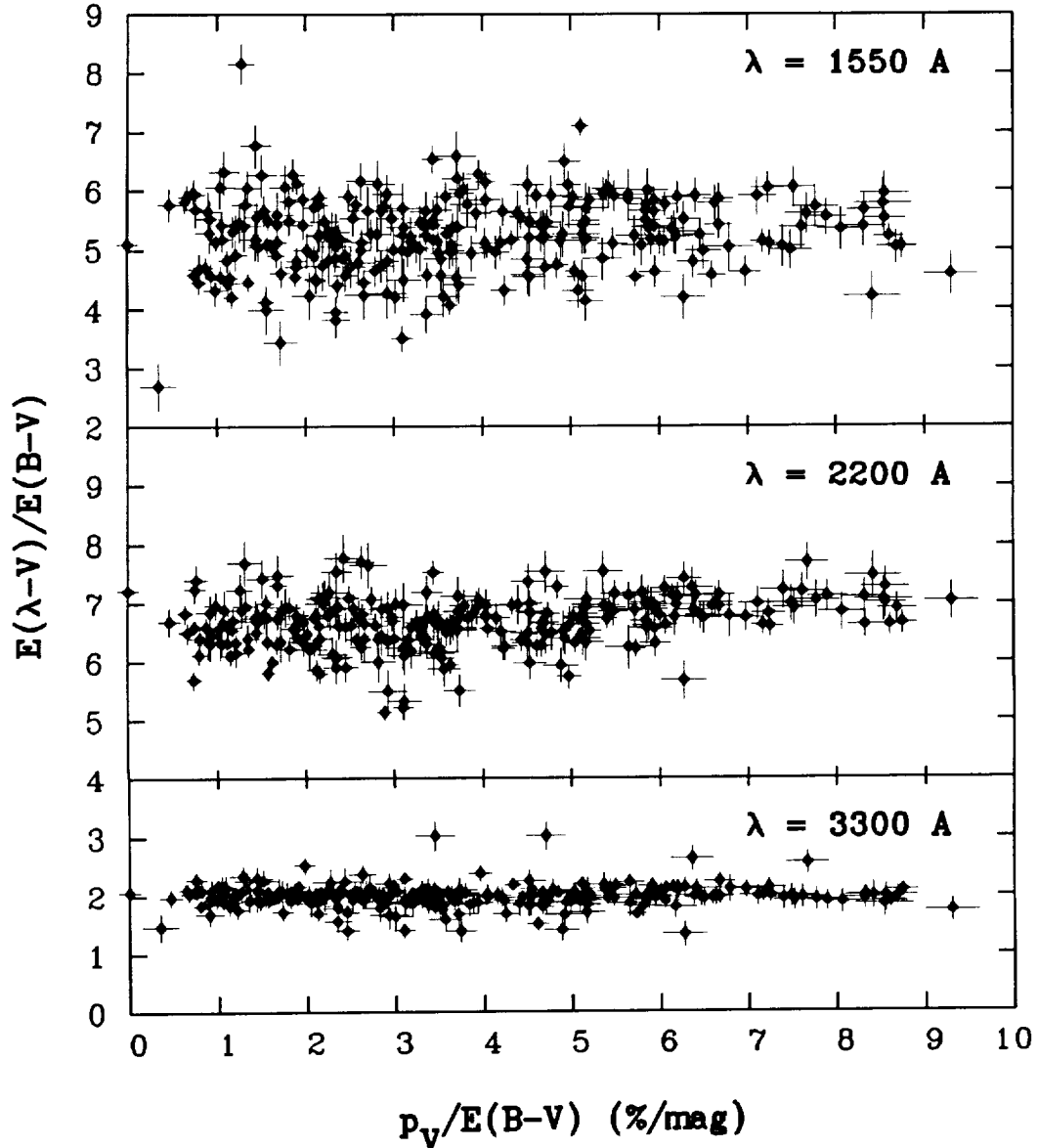

Figure 2. Dependence of $E(\lambda-V)/E(B-V)$ on $p_V/E(B-V)$. The bars show a mismatch of 1 spectral subclass of stars.

Table 1. Means and Standard Deviations of E(λ-V)/E(B-V)

$\dfrac{p}{E(B-V)}$		$\dfrac{E(33-V)}{E(B-V)}$	$\dfrac{E(25-V)}{E(B-V)}$	$\dfrac{E(22-V)}{E(B-V)}$	$\dfrac{E(18-V)}{E(B-V)}$	$\dfrac{E(15-V)}{E(B-V)}$
0-2 (m=1.28)	m	2.03	4.17	6.58	4.91	5.25
64 stars	σ_{n-1}	0.16	0.38	0.67	0.60	0.81
2-4 (m=2.95)	m	1.97	4.09	6.57	4.77	5.14
99 stars	σ_{n-1}	0.21	0.31	0.50	0.46	0.60
4-6 (m=5.02)	m	1.98	4.13	6.70	4.94	5.39
67 stars	σ_{n-1}	0.20	0.26	0.36	0.39	0.55
>6 (m=7.24)	m	2.02	4.24	6.96	4.96	5.33
42 stars	σ_{n-1}	0.19	0.25	0.32	0.34	0.47
All (m=3.73)	m	2.00	4.14	6.66	4.87	5.26
272 stars	σ_{n-1}	0.19	0.31	0.51	0.47	0.64

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