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Dust in a Hostile Environment: Interstellar Dust in the Line of Sight to HD 62542

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Abstract. HD 62542 is situated in a line of sight toward a ridge of dark matter in the Gum Nebula. That region is under the influence of UV radiation and stellar winds from hot stars. We use for the first time interstellar polarization and extinction data from the ultraviolet to the infrared in order to study and quantify the influence of such an environment on the size of the dust particles.

1. Introduction

The Gum Nebula is a large ($\approx$ 250 pc), complex structure, 400 pc distant and possibly formed by ionization and winds from embedded OB stars (Sahu 1992). Its angular diameter is about 36 degrees, scattered through Puppis and Vela. In Hα, the nebula shows patches and filaments consistent with an expanding, bubble-like nebula (Reynolds 1976a; Weaver et al. 1977). The observed Hα

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emission seems consistent with the ionization originating from two main sources, ζ Puppis (O5 Iaf) and γ Velorum (WC8 + O9 I) (Reynolds 1976 a,b).

The star HD 62542 (B5 V) is at a projected angular distance of about 10° WSW from the center of the nebula and it is seen toward a ridge of dark matter (Cardelli & Savage 1988 [CS88]). The eastern edge of the cavity is rather sharp, as though it has been emptied by the winds from ζ Puppis and γ Velorum (CS88, their Fig. 6). Part of the emission from the cavity walls, through which HD 62542 is seen, may come from shocks caused by the winds from these two hot stars (CS88).

CS88 found that HD 62542 presents a quite unusual ultraviolet (UV) extinction bump, centered at 2110 Å as opposed to the observed Galactic average of 2175 Å. Further, they also found that the far UV extinction toward HD 62542 is the highest so far found in the Galaxy. Clayton et al. (1992) report observations by Magalhães and Rodrigues which show that the wavelength of maximum polarization, $\lambda_{\rm max}$, is 0.59 μm, just slightly over the average Galactic value. Our aim in this contribution is to use both extinction and polarization data of HD 62542 in order to constrain the size parameters of the dust in an environment which is far different from the average diffuse interstellar medium.

2. Data

Ultraviolet (UV) spectral data for HD 62542 has been taken from the IUE data bank (CS88). For the infrared (IR), we have used the photometric data from Whittet et al. (1993). The latter work showed that the value of R_V ($= A_V/E_{B-V}$) is similar to that in the average diffuse interstellar medium.

For the polarimetry, we have used UV spectropolarimetric data obtained with the Wisconsin Ultraviolet Photo-Polarimeter Experiment (WUPPE; Clayton et al. 1992) from 1400 Å to 3200 Å. In the optical, the data was gathered with the VATPOL polarimeter (Magalhães et al. 1984) at CASLEO observatory. In the IR, the data was obtained with the Hatfield polarimeter (Bailey & Hough 1982) at the Anglo-Australian Telescope. The polarimetry data are shown in Fig. 1.

3. Dust Model Fits

We have used the basic model of Mathis, Rumpl & Nordsieck (1977 [MRN]) but with several additional modifications, as we fit not only extinction but also polarization. We assumed that the dust consists of spherical particles of silicate (enstatite) and graphite and cylindrical silicate grains, each with a power law size distribution with exponent −3.5. The size distribution of the silicate spheres is taken from a minimum size up to the initial size of the cylindrical silicate size distribution. Further, the normalization constants of each of these distributions were calculated such that the volume distribution was continuous (Rodrigues, Magalhães & Coyne 1996), as opposed to the more usual size continuity assumption.

Initially, the polarization data were fit with silicate cylinders and that defined the minimum and maximum cylindrical particle sizes. Then, the extinction

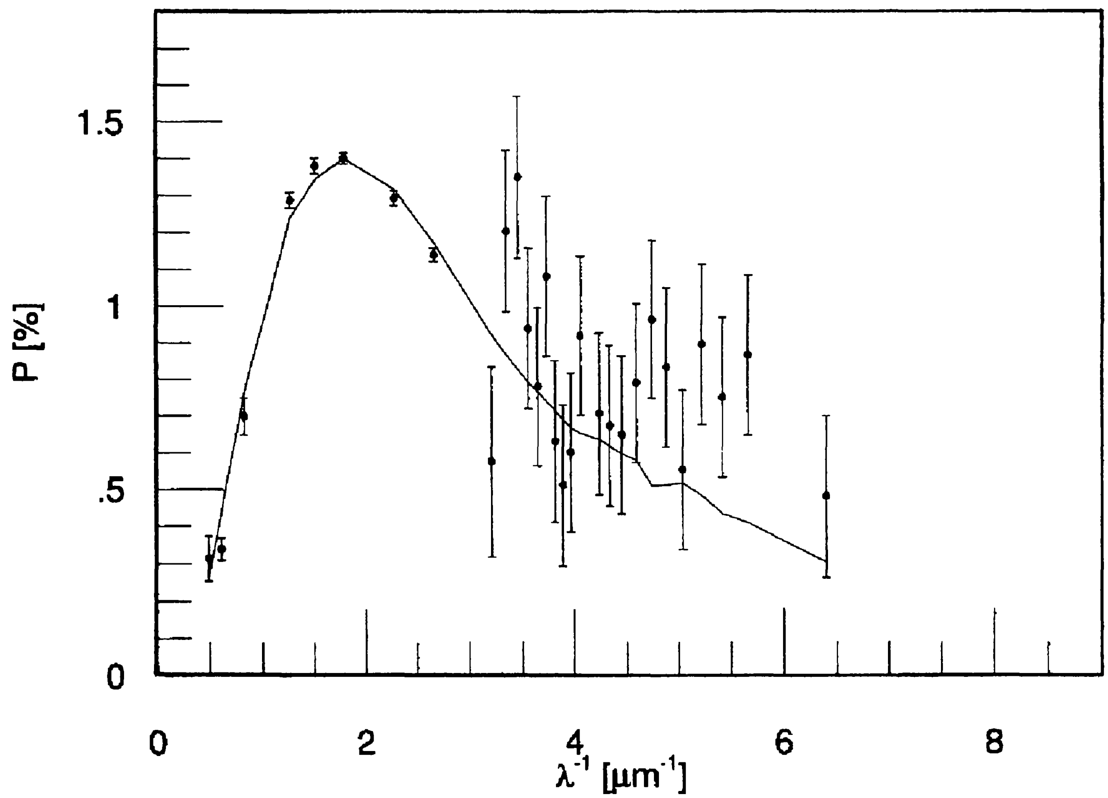

Figure 1. Interstellar polarization by dust toward HD 62542. Dots with error bars indicate observations in the ultraviolet (Clayton et al. 1992), optical and infrared (this work). The continuous line is a fit with the model discussed in the text.

curve was fit using this cylindrical particle component together with the silicate and graphite spheres. The fit to the extinction defined the lower limit of the spherical silicate size distribution and the lower and upper limits of the graphite grain size distribution.

This simultaneous fit to both polarization and extinction data is discussed in detail by Rodrigues, Magalhães & Coyne (1995b). The reader is also referred to the contribution of Rodrigues, Coyne & Magalhães (1996a) in these proceedings.

4. Results

Our fit to the polarization data is shown in Fig. 1. The dust size parameters obtained from the fits to both polarization and extinction are given in Table 1. The size parameters under "MRN" in the table are the ones typically assumed for interstellar dust in the diffuse Galactic interstellar medium.

Table 1. Sizes of interstellar grains (in μm) toward HD 62542.

Dust Component	Gum Nebula (This work)	Diffuse Medium MRN
Silicate spheres	0.003—0.010	0.020—0.250
Silicate cylinders	0.010—0.183	—
Graphite spheres	0.015—0.130	0.005—0.250

The sizes for silicates from MRN (Table 1) are from a fit to the Galactic extinction only. Nevertheless, the average silicate grain size toward HD 62542 is seen to be somewhat smaller than the Galactic average. For the graphite grains, the size distribution is clearly distinct from the Galactic size distribution. It would hence appear that a fraction of the larger grains toward HD 62542 is preferentially destroyed, showing that the shocks and UV radiation present in that environment do indeed affect the grain population. This conspires to produce normal values of R_V and $\lambda_{\max}$ and yet a steep rise of the extinction curve into the UV.

A more thorough analysis of the data, including additional UV spectropolarimetric data gathered by WUPPE during the Astro-2 mission, will be presented elsewhere.

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