Ultraviolet Interstellar Extinction In The Small Magellanic Cloud

ALI ABD AL SATAR

MUWAFAQ F. JADOO'A

Department of Physics, College of Science / Muthana

Qadisiya University

E-mail: aliabdsatar@yahoo.com

Abstract:

It is shown that available and ultraviolet data relating to the interstellar dust are elegantly explained on the basis of modified microbial model. The microbial grain model developed by Fred Hoyle

and Chandra Wickramasinghe can be fitted well to the normalized extinction of SMC . Which explains that microbial model is responsible for the behavior of interstellar extinction in this region.

1- Introduction

For over half a century, astronomers have known that interstellar space is not an empty and featureless vacuum. They found that between the stars there exists matter in a variety of forms: single atoms,ions, molecules of varying degree of complexity .Dust particles or interstellar grains as they are known , are tiny solid particles , the nature of this particles remains to this day a major unsolved problem in astronomy , and astronomers are still searching to understand their properties , shapes, size, composition and how they might be formed . Hoyle and Wickramasinghe [(1)] have argued that interstellar grains must have a biogenic origin, being generally similar in character to terrestrial microorganisms.

In the present paper we consider in detail the behavior of a modified microbial grain model at optical and ultraviolet wavelength, $1.89\mu m^{-1} < \lambda^{-1} < 7.84\ \mu m^{-1}$ .It is at these wavelength that interstellar grains show up most conspicuously ,and where much of the energy output of stars is scattered and absorbed by the dust.

2- The Small Magellanic Cloud

The Small Magellanic Cloud (SMC) is the second nearest galaxy to the Milky Way, (the LMC being the nearest) and is at the distance of about 240,000 light years, quite close enough for it to be resolved

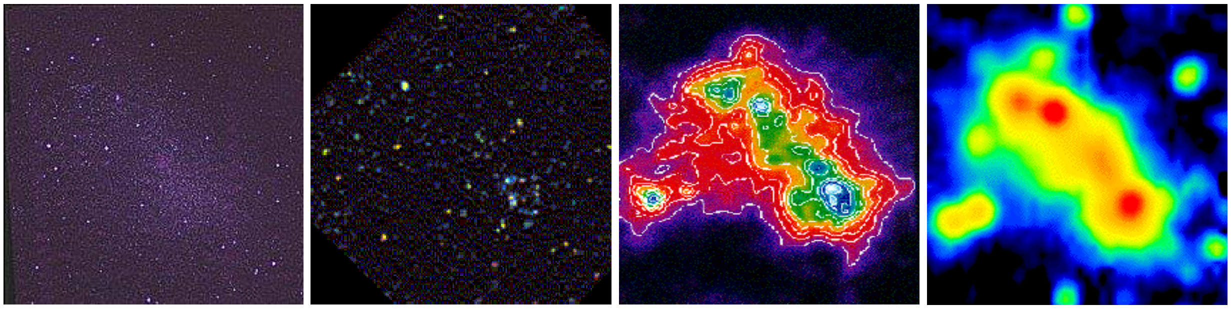
The shape of the SMC defies description and it is therefore classified as an 'irregular' galaxy. However, since galaxies show a strong tendency to be symmetrical and irregulars are rather rare we could be seeing first hand evidence of its recent tidal disruption by the combined effects of both our Galaxy and the LMC. Since the SMC is the least massive of the three it is the most likely member of this interacting trio to be seriously distorted by the encounter. The large globular cluster at right in figure (1) is 47 Tucanae, while a smaller one at the top of the picture is NGC 362. Like its larger apparent neighbor, the Large Magellanic Cloud, the Small Magellanic Cloud was certainly known to the ancient southerners, but became known to us only when Magellan went on his journey around the world, in 1519. The main body of the Small Magellanic Cloud has been assigned NGC 292 in Dreyer's catalog [3], which is now sometimes used for this galaxy. In addition, many clusters and nebulae which are members of this galaxy have been given their own NGC numbers.

This galaxy looks like a piece of the Milky Way for the naked eye. It orbits our Milky Way galaxy at about 210,000 light years distance, which makes it the third-nearest external galaxy known (after the LMC and the 1994 discovered Sagittarius Dwarf Elliptical Galaxy). Our current distance value takes into account the corrected Cepheid distance scale based on the Hipparcos satellite data published in early 1997.Figure (2) shows some pictures of SMC in different wavelengths and table (1) listed some information about it [3].

Table1: Information about SMC [3]

Right Ascension	00: 52.7 (h: m)
Declination	-72: 50 (deg: m)
Distance	210.0 (kly)
Visual Brightness	2.3 (mag)
Apparent Dimension	280 x 160 (arc min)

X-Ray Ultraviolet Visible

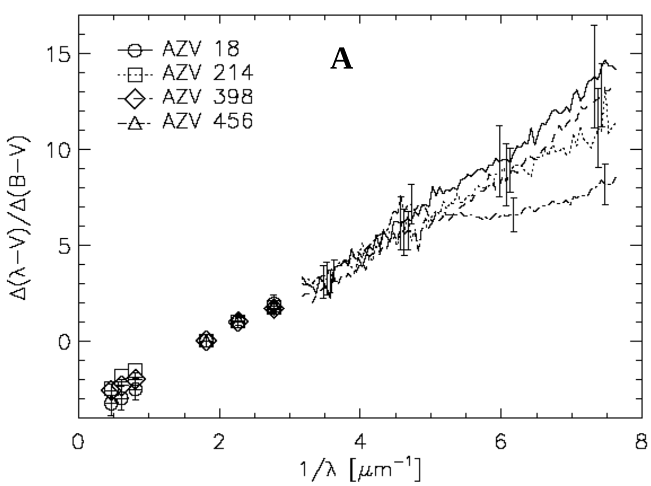


Near-Infrared Mid-Infrared Far-Infrared Radio

Figure2: Pictures of The Small Magellanic Cloud in Different Wavelengths

3- The Extinction Curve of SMC

The UV extinction curve for the SMC is in general characterized by the absence of the 2200 Å bump, in contrast to the galactic curve (see figure (3))[5][6]. The absence of the bump features in the SMC may therefore be related to the large under abundance of carbon in this galaxy. Constructed UV extinction curves for SMC targets and detected the 2200 Å bump only towards AzV 456 (figure 4)[6], which is located in the SMC wing. In exactly this target AzV 456 (Sk143) have a strongest Diffuse Interstellar Bands at 5780 and 5797 Å, from this observations we can indicate that some DIBs carriers can be formed at low carbon abundances.



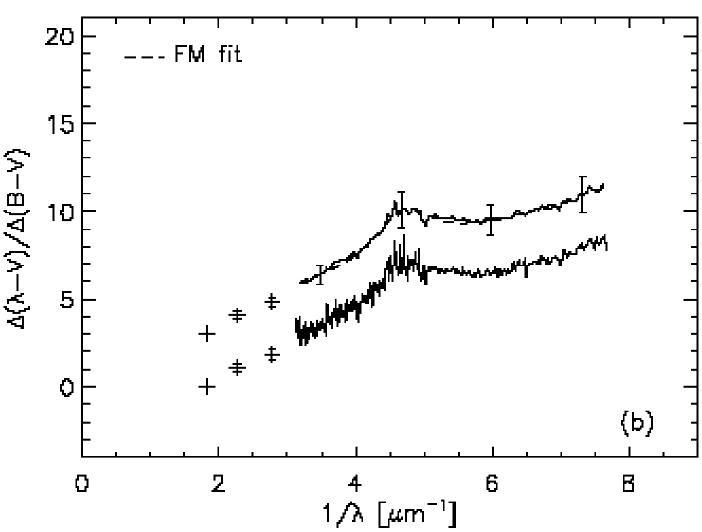


Figure 4: Extinction Curve of AZV456 [6]

4- microbial Model:

In late 1970s, Prof. Sir Fred Hoyle and Prof. Chandra Wickramasinghe [7] and Jabir, et al [8] have argued that interstellar grains have a biogenic origin, being generally similar in character to terrestrial microorganisms. They first argued that interstellar extinction data over the visual waveband could be explained with remarkable precision by terrestrially determined size distribution of space forming bacteria, provided account is taken of the evacuation of free water under interstellar condition. Later proposed that interstellar grains are distributed between three main classes of particles [9].

1- Bacterial grains in the form of long hollow needles with cavities due to evacuation of water. The average refractive index (m) has been taken to be m=n-ik, where n is equal to 1.149, 1.16 and 1.167 and k is varied in the range 0.0 To 0.25 with mean radius=1/3 μm.

2- Graphite spherical particles of mean radius 0.02μm and complex refractive index is wavelength dependent.

3- Small dielectric spheres, of radius 0.04μm, and complex refractive index varied with wavelength.

In the three-component model the smaller dielectric component was identified with mycoplasmas and the graphite spheres were taken to be degraded bacterial cells [10].

Jabir, et al [9] have used this model and the Mie formulae to compute the extinction properties of the spherical grain species of component 2 and 3 and the corresponding formulae for infinite cylinders to compute the properties of cylindrical bacterial grains species of component 1.

The combined extinction behavior of the three component model were calculated according to the expression [10]:

$$Q(\lambda) = \frac{Q_{ext}^{(1)}(\lambda)}{Q_{ext}^{(1)}(\lambda_o)} + wg\,\frac{Q_{ext}^{(2)}(\lambda)}{Q_{ext}^{(2)}(\lambda_\circ)} + wd\,\frac{Q_{ext}^{(3)}(\lambda)}{Q_{ext}^{(3)}(\lambda_\circ)}$$

……………….……..(1)

Where $\lambda_\circ = 1.8\,\mu m^{-1}$ and **wg** and **wd** are the weighting parameters specified such that the contribution from individual species to the extinction at $\lambda^{-1} = 1.8\,\mu m^{-1}$ are in the ratio:

Hollow needle(1):graphite(2):dielectric spheres(3)

1.0 : wg : wd………..(2)

The total extinction coefficient calculated from equation (1) and then normalized to obtain:

$$\frac{E_{(\lambda - v)}}{E_{(B - v)}} = A + BQ(u)$$

……………………………………….…………(3)

Where A and B are two normalization factors chosen so as to give two specified values of normalized extinction two specific wavelengths.

5-Theoretical Microbial Model For SMC Extinction Curve

The constituents of our microbial grains model are of three kinds:

1.Bacterial grains with size distribution taken from laboratory data with these grains in the form of long hollow needles of long lengths compared with radii. The axes of the needles are further assumed to the randomly oriented in space. The average refractive index has been taken to be m = 1.16 –0.015i .

2.Graphite grains in the form of spheres of radius = 0.02 and their optical constants taken from Taft and Phillipp.[11]

3.Dielectric spheres of refractive index = 1.5 – 0.0i and radius = 0.04 µm (These grains produce sufficient scattering in the far ultraviolet at wave length short ward to 1200 A^0 in accord with observation).

The combined extinction behavior of the three species is calculated according to equation (1). The weight factor for graphite **wg** and the weight factor for dielectric spheres of radii 0.04µm are defined as in(3).We normalize the total extinction curve for our microbial grain ensemble to:

$$\Delta m = 2.65 \text{ at } \lambda^{-1} = 3.34\ \mu m^{-1}$$

$$\Delta m = 7.71 \text{ at } \lambda^{-1} = 5.7\ \mu m^{-1}$$

We found the best agreement for our microbial model with the extinction law in SMC to be obtained where the contributions from individual grains species to the extinction at $\lambda^{-1} = 1.8\ \mu m^{-1}$ are in the ratio:

Hollow needles:	graphite sphere :	dielectric spheres
1	0.01	0.02

Our theoretical model and the observations data taken from ref. (4) are plotted in Fig. (5), we note that agreement with observation is remarkably good.

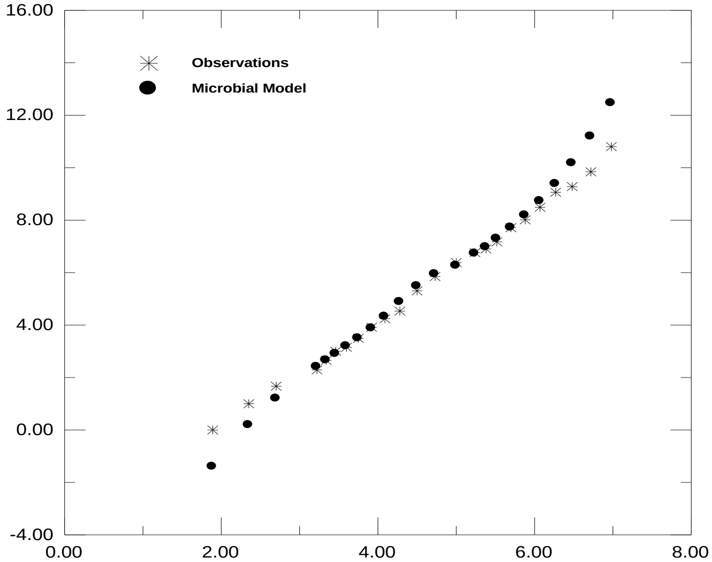


Figure 5: The Normalized Extinction Curve For SMC Fitted with Microbial Model.

6-CONCLUSIONS

The consideration, which was put forward by Hoyle and Wicramasinghe concerning the responsibility of microorganisms for producing the behavior of interstellar extinction, was found more likely. Their result and ours reinforced this consideration.

Computation of the detailed optical properties of SMC over the wave band $1.89\mu m^{-1} < \lambda^{-1} < 7.84\ \mu m^{-1}$ for three biologically derived components of this model is shown to be in close agreement with the observational data of interstellar dust, with simple differences specially in the far ultraviolet region because of disunform distribution of grains and the differences in the density.

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