Journal of Kerbala University , Vol. 10 No.1 Scientific . 2012

Investigation the Interstellar Dust toward the Galaxy M82

تفسير الغبار ما بين النجوم باتجاه المجرة M82

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ABSTRACT:

The composition of the interstellar dust remains controversial .The 10µm absorption feature has been analyzed in terms of silicate for a long time, In this paper we had compared between absorption toward the galaxy M82 and infrared spectra of organic and biological materials. We obtained a good agreement relatively with spectrum of Murchison meteorite. This meteorite composition contains organic and amino acids components which are the basis of DNA of the cells.

الخلاصة :

ان تركيب الغبار ما بين النجوم يبقى مثار جدل فقمة الامتصاص ١٠مايكرون قد فسرت بدلالة السليكات لوقت طويل . في هذا البحث قارنا بين الامتصاصية باتجاه المجرة M82 والاطياف تحت الحمراء لمواد بايلوجية وعضوية . لقد حصلنا على توافق جيد نسبيا مع طيف مادة نيزك ميرشيسون . هذا النيزك يحتوي على مكونات عضوية واحماض امينية والتي تمثل الاساس ل(دنا) الخلية الحية.

1-Introduction

The interstellar medium (ISM) is that region in space between the stars, it is a very important component of the galaxy which represents the material that forms the stars by the process of the gravitational collapse. It is enriched in heavy elements from time to time whenever a massive star explodes and throws out the heavy elements formed in the hot stellar core in to the surrounding medium. The ISM consists of a mixture of several elements mainly hydrogen ~ 90% and helium ~ 10% in a gaseous form and a small fraction of heavy elements in the form of tiny submicron sized particles known as dust grains. The dust is a combination of grains generated in dying stars and modified in the ISM. Although the dust comprises only a small amount of material in the ISM by mass (i.e., 1%), it plays a significantly larger role in interstellar chemistry. Dust grains in the diffuse interstellar medium are composed of both (oxygen-rich) and (carbon-rich) material. While the O-rich component is attributed to amorphous silicates, the composition of the C-rich component remains controversial, proposed candidates including graphite, diamond, amorphous carbon, aromatic and aliphatic hydrocarbons, and organic-refractory residues [1].

2- Theory

2.1- Interstellar Clouds

Astronomical molecules are found in diverse environments, ranging from nearby objects in our solar system to distant sources in the early universe. The term ‘cloud’ has been adopted historically to describe visual features, such as Barnard’s dark nebulae and co-moving clumps of gas responsible for the Doppler components in the spectral line profiles. This term may be somewhat misleading, however, in that the ISM now appears to be not only inhomogeneous but also hierarchical in structure (‘clumps within clumps’). In the modern view, we may define clouds to be peaks in the density distribution on size scales that correspond to observed concentrations of interstellar gas and dust even clouds of similar size and mass may have quite different morphological structures. It is convenient to adopt the labels ‘diffuse’ and ‘dense’ to describe clouds in which the gas is predominantly atomic and molecular, respectively. An idealized representation of a cloud of each type is shown in figure (1). Both are assumed to lack internal sources of luminosity and to be immersed in a substrate of hot, ionized gas (the inter cloud medium) [2].

A *diffuse cloud* is a cloud of moderate density (n_H= 107–108 m^{-3}) and extinction ($0.1 < AV < 1$) in which the dominant phase is H I. A typical example might have dimensions ≈ 5 pc and mass ≈ $30M_O$ (but with large scatter from one to another). A diffuse cloud is optically thick to radiation beyond the Lyman limit ($hv \geq 13.6$ eV) but remains relatively transparent to radiation of energy in the range 11.2–13.6 eV that can dissociate H_2 nevertheless, some simple gas-phase molecules (e.g. CO, OH, CH and CH+, as well as H_2) have detectable abundances. Cool H I gas is encased in a shell of warm gas, the outer ‘halo’ of which is partially ionized by the hard ultraviolet photons in the ISRF, which it strongly absorbs. The warm gas is predominantly neutral, and heated by soft x-ray photons ($hv \approx 40–120$ eV) emitted by hot intercloud gas. The least massive, most tenuous diffuse clouds may lack to a cool phase entirely: these tend to be short lived due to evaporation into the surrounding hot medium. [3]

A *dense cloud* contains regions sufficiently dense (n > 108 m^{-3}) that virtually all the H is converted to H_2 by grain surface catalysis on timescales of order a few million years, short compared with their expected lifetimes. Such conditions are found in regions ranging from small (<1 pc), low mass (<50 M_) clumps within dark clouds to giant molecular clouds ranging up to ≈ 50 pc and ≈ 106 M_O in size and mass. Dense molecular gas is opaque to both ionizing and dissociating radiation. It is effectively self-shielded from the external ISRF by the outer layers of the cloud itself, which remain predominantly atomic and in which dissociating photons are attenuated by both gas and dust. The transition zone between the atomic and molecular gas is termed a photo dissociation region [3].

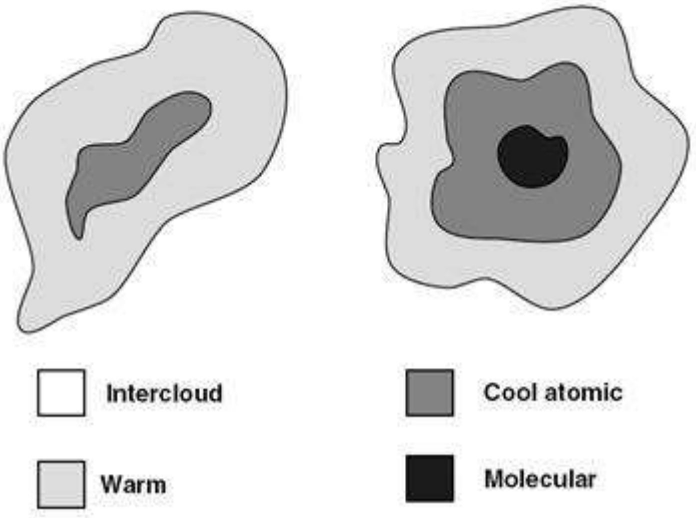

Fig.(1): An idealized representation of the structure of diffuse and dense clouds in the ISM.

2.2- Composition of Dust Grains

Dust grains are thought to be composed of refractory materials like carbon, silicate , etc…, Many other elements like nitrogen, magnesium, phosphorous, sulphur , chlorine, potassium and iron, which are stable also seem to be present in grains. Rather than being composed of one element, dust grains consist of a mixture of several elements and molecules. The presence of silicate absorption feature in the ISM and the observed depletions of refractory metals suggest that amorphous silicate (e.g. olivine) must be a dominate component of the interstellar dust. In addition the 2200Å bump present in nearly all stellar extinction curves indicate that amorphous carbon must also present. Typical size of interstellar grains range from 3 to 300 nm, and polarization studies clearly indicate clearly that the large grains are non spherical [4].

2.3 - Absorption and Infrared Emission

Absorption is the complementary process to scattering where the incident radiation that is not scattered is absorbed resulting in an increase in the internal energy of the grain. The equilibrium between absorption and emission of radiation depend on the optical properties of dust grains, like cross-section and the albedo besides the distance between the stars and the grains. Absorption feature at infrared wave lengths result from molecular vibrations with the grain material. Comparison with laboratory data is the key to reliable interpretation of astronomical spectra. Assignments of solid-state features to specific molecules cannot always be made purely on the basis of wavelength coincidence. A given absorption is assigned initially to a chemical bond rather than to a specific molecule and ambiguities may occur when vibrational modes in different species arises at similar wavelengths: a prime example in the C-H stretch at λ=3.4µm which will occur in any species that contains H bonded to C [5]. As interstellar grains are generally expected to form in an amorphous state to become crystalline only if subjected to sub subsequent heating, infrared spectroscopy offers the possibility of explore their thermal evolution as well as chemical composition [6].

2.4 - The 10µm Band Biology

For over a decade astronomers have attempt to match an absorption feature in the 8-12µm wave band produced by interstellar grains with various grain models. A mixture of naturally occurring silicates was first considered. Latter attempts to improve this situation invoked properties of both amorphous as well as hydrated silicates. In 1979 Hoyle and Wickramasinga began developing the theory that interstellar grains might include freeze- dried microorganisms and that such micro organisms included in comets and meteorites may have led to the origin of life on our plant. The first attempt to explain the 8-12µm feature in terms of intact biological material led to an astounding success. They obtained a mixed culture of diatoms from a local river consisting (60% Diatoms and 40% purely carbonaceous microorganism).[7]. Amino acids, the molecular building blocks of proteins, certainly played a key role in both the emergence of cellular life on earth and the development of bio molecular asymmetry. We experimentally simulated the abiotic formation of amino acids and diamino acids in interstellar ices by the effect of UV irradiation on CO, CO_2, CH_3OH, NH_3, as well as H_2O and identified 16 amino acids among the remaining products [8].

3- Observation of the Galaxy M82

M82 contains a strong, extended source of 2-20µm radiation with an energy distribution similar to that of Seyfert galaxy. The position of infrared source is roughly coincident with an extended , non thermal radio source. Observation of M82 made a $7''$ beam centered at several points in the region $111'' \pm 2''$ N and $83'' \pm 4''$E of BD $+70^0 587$. Within this region the absolute flux at a fixed wavelength varied by up to ±30 percent. All spectra were normalized and then averaged together to produce a composite spectrum of the central region of M82. The resulting spectrum is shown in figure (2). [9].

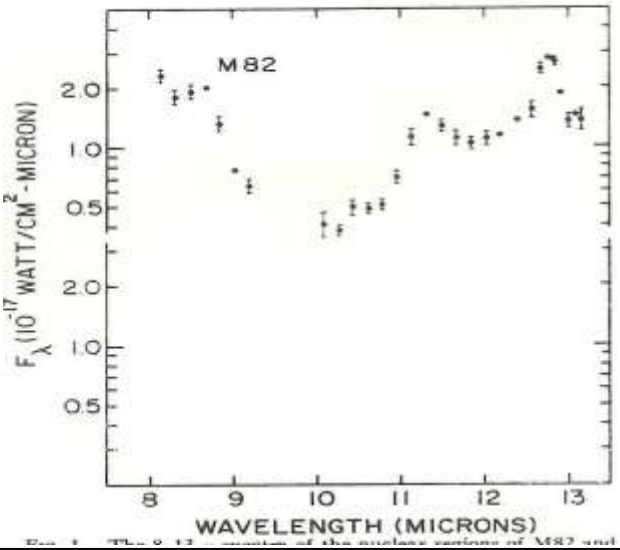

Fig.(2): The 8-13µm spectrum of the galaxy M82

4- Experimental Work

we have been used the infrared spectra of the following materials to obtain the best agreement with observation of the galaxy M82 which were (organic &biological) included [10]:

1- Murchison meteorite , figure (3)
2- E-coli bacteria , figure (4)
3- Blue green algae , figure (5)

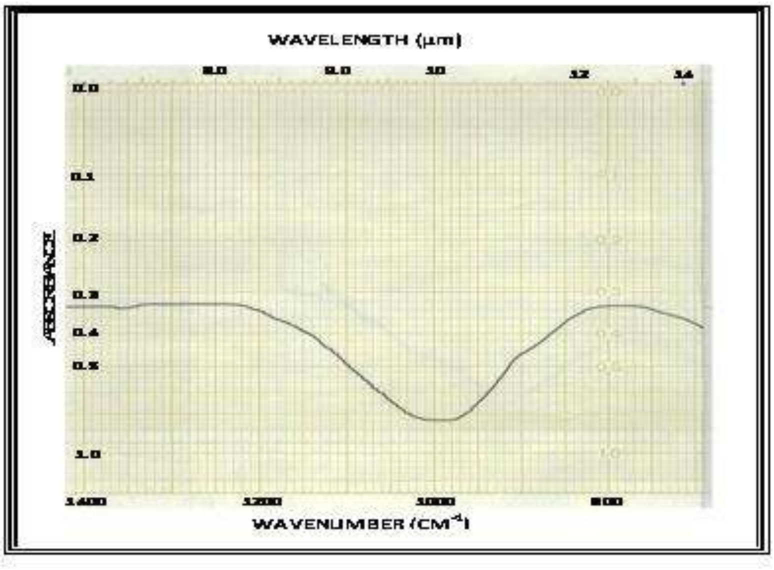

Fig. (3): The infrared spectrum of Murchison meteorite

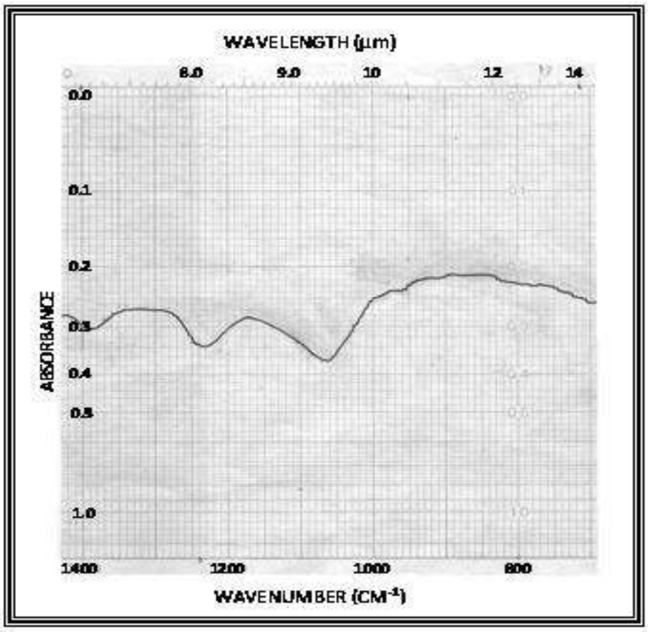

Fig. (4): The infrared spectrum of E.coli bacteria

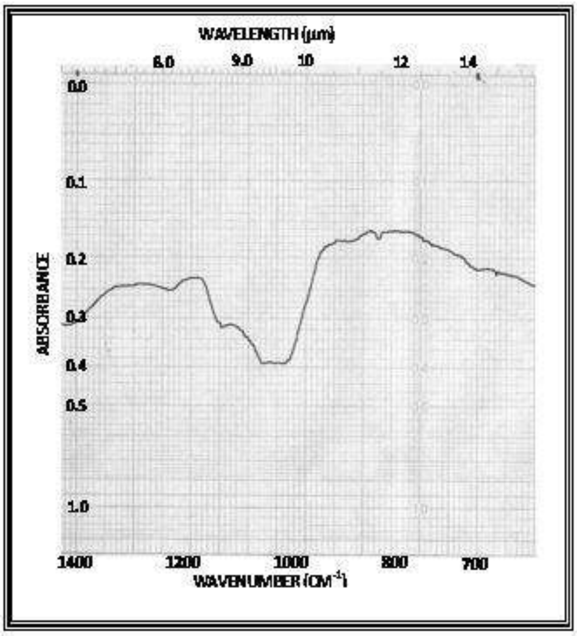

Fig. (5): The infrared spectrum of Blue-green algae

To obtain the flux of these materials, we used the following relation which represents an exponential function [10]:

$$F = \xi\beta \exp\left(-\tau\,\alpha\right)$$

where β is Planck's function = $(2hc^2/\lambda^5) * (1/\exp(hc/\lambda KT)^{-1})$

τ= -log(transmittance) , ξ , α constants

By using two main programs, firstly (Get data graph digitizer) to obtain data from observation and materials spectra. Secondly (MathCAD 13) to calculate and compare the fluxes of materials with the flux of observation. The results have been obtained are shown bellow as a models:

Model (1): Comparison the observation with Murchison meteorite spectrum, as shown in figure (6), where
T=380 K , $\alpha = 3.8$, $\xi = 0.04$

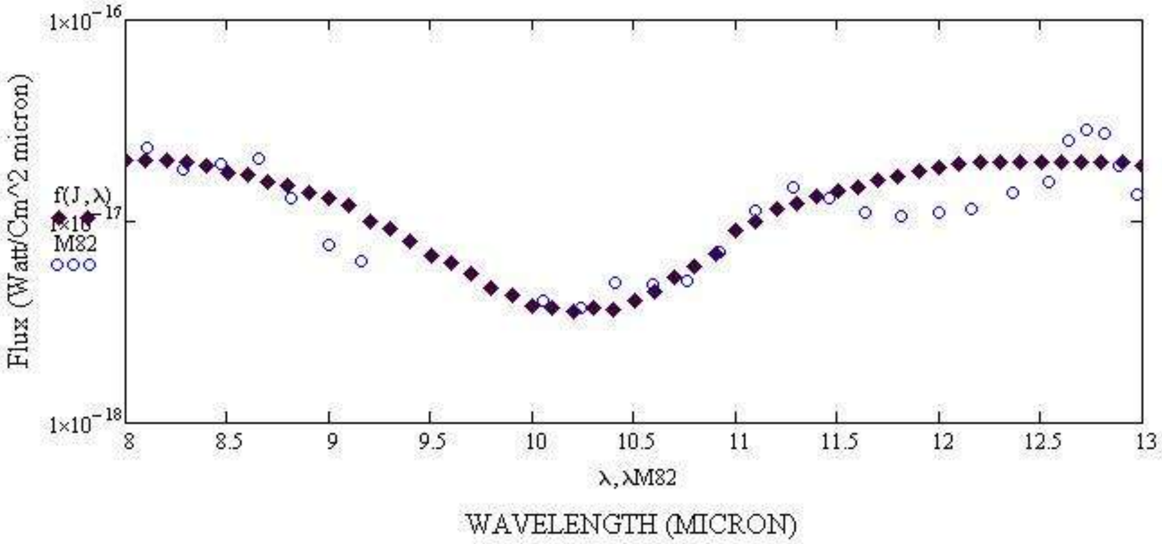

Fig.(6) Model (1) Comparison the observation(o) with Murchison meteorite spectrum (♦).

Model (2): Comparison the observation with E-coli bacteria spectrum, as shown in figure (7), where: T=240 K , $\alpha = 14.6$, $\xi = 0.04$

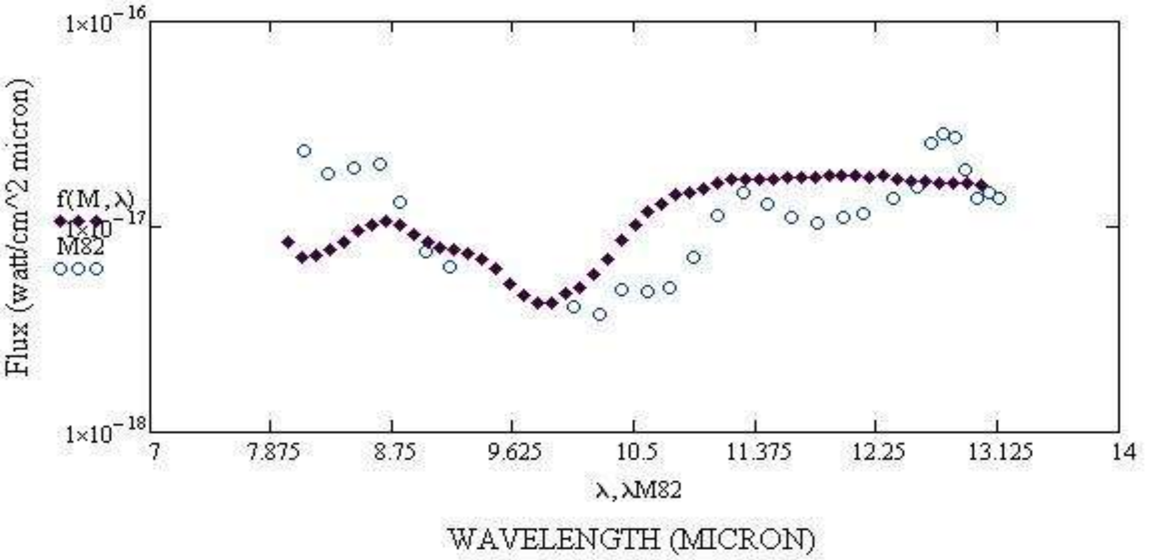

Fig.(7) Model (2) Comparison the observation(o) with E-coli bacteria spectrum (♦).

Model (3): Comparison the observation with Blue green algae spectrum, as shown in figure (8), where : T=240 K , $\alpha = 14$, $\xi = 0.027$

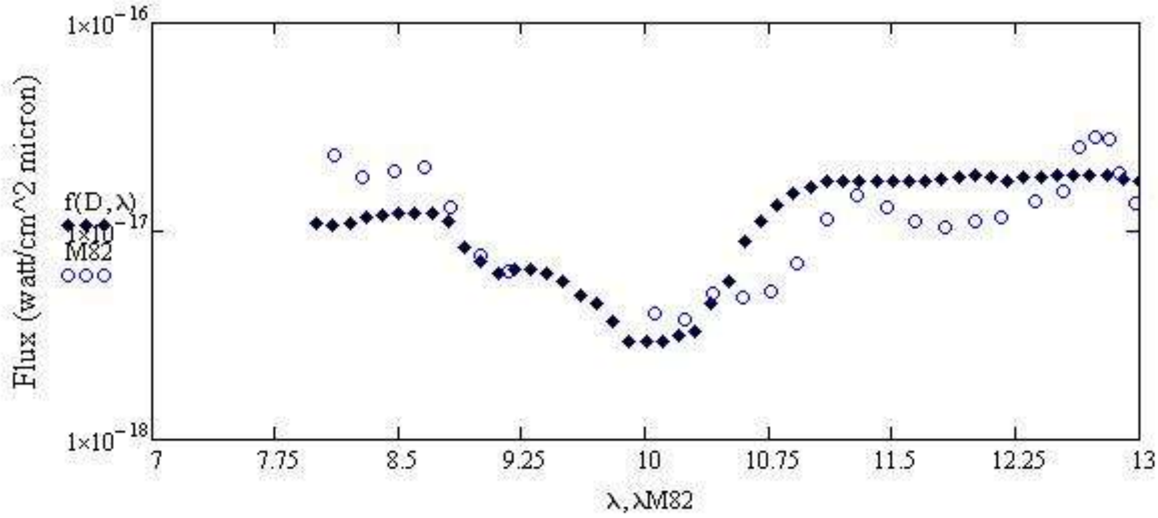

Fig.(8) Model (3) Comparison the observation(o) with Blue green algae spectrum (♦).

5- Conclusions

Analysis the region 8-13µm toward the galaxy M82 with biological materials (E-coli bacteria & Blue green algae) is not succeeded and there are clear difference between the observation and the models (2 & 3), but there is a good agreement with spectrum of Murchison meteorite specially in absorption feature near 10 µm. These results show that molecules as complex as amino acids are, indeed, synthesized in interstellar and/or interplanetary environments. They also illustrate the viability of delivery to Earth.

6- References

1- Draine, B. T. 2003, ARA&A, 41, 241
2- Elmegreen B G, 2002 Astrophys. J. 564- 773
3- Hollenbach D J and Tielens A G G M ,1997, *Annu. Rev. Astron. Astrophys.* 35, 179
4- Spitzer,L.S., Fitzpatrick,E.L.,1993,ApJ,409,299
5- Grim,R.J.A, Baas, F., Geball,T.R., Greenberg, J.M., & Schutte , W.,1991,Astron.Astrophys.,243,473
6- Whittet D.C.B., Dust in the Galactic Environment, 2nd Edition, 2003,IOP Publishing
7- Richard,B., Fred Hoyle, N.C. Wickramasinghe, Miriam,J., &S. Almufti, 1986,Earth,moon,and planets, 35,19-45
8- Meierhenrich, U. J. ,2008, Amino acids and the asymmetry of life, Springer, Berlin
9- Gillitt ,F.C., Kleinmann D.E., Wright E.L., 1975,ApJ,198,L65-L68
10- Majeed Q.S.1990, PhD Thesis, University of Cardiff