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A Note on a Biological Explanation for the ERE Phenomenon

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The phenomenon of extended red emission in galactic sources, known for nearly 3 decades is best explained on the basis of biological pigments. Pigments associated with the "Red Rain of Kerala" provide a good model, although other biological pigments more generally would also serve well as a possible explanation.

Keywords: Interstellar dust, astrobiology, extended red emission

Abstract

Whilst we have attempted to account for many of the properties of interstellar dust with a primarily biological/bacterial model, one remaining set of observations that needs to be understood relates to the so-called Extended Red Emission (ERE) phenomenon. This phenomenon is also elegantly explained with a biological model of dust.

1. Introduction

The likely biological origin of infrared and ultraviolet spectral features in interstellar dust has been discussed over several decades and the relevant arguments have been reviewed in earlier papers in the present volume (1,2,3). Here we focus on perhaps one of the most bizarre spectroscopic phenomena in astronomy that defies a simple inorganic or non-biological explanation. This is the so-called extended red emission of interstellar dust (ERE), showing up as a broad fluorescence emission band over the red wavelength range 5000–7500A. The feature has been observed extensively in planetary nebulae (Furton and Witt, (4), HII regions (Perrin and Sivan, (5)), the red rectangle, and in many dark nebulae (Schild et al (6-10)). High latitude cirrus clouds in the Galaxy as well as in extragalactic systems also show the same phenomenon.

2. Role of Aromatic Molecules

We have discussed elsewhere how ensembles of aromatics can account for both UIB's (Unidentified Interstellar Bands) and the UV extinction feature 2175A in interstellar dust. The diffuse interstellar absorption bands (DIB's) in the optical spectra of stars, particularly the 4430A feature, also have possible explanations on the basis of molecules such as porphyrins (3). The ERE phenomenon has a self-consistent explanation on the basis of fluorescence of biological chromophores (pigments), e.g. chloroplasts and phytochrome. Competing models for ERE based on emission by non-biologically generated compact PAH (polyaromatic hydrocarbon) systems are unsatisfactory as is evident in Fig. 1. Hexa-peri-benzocoronene is

one of a class of abiotic models that has been discussed in this context in the astronomical literature. However, the width and the central wavelength of its fluorescent emission leave much to be desired, and thus it cannot be claimed as a decisive identification of this feature.

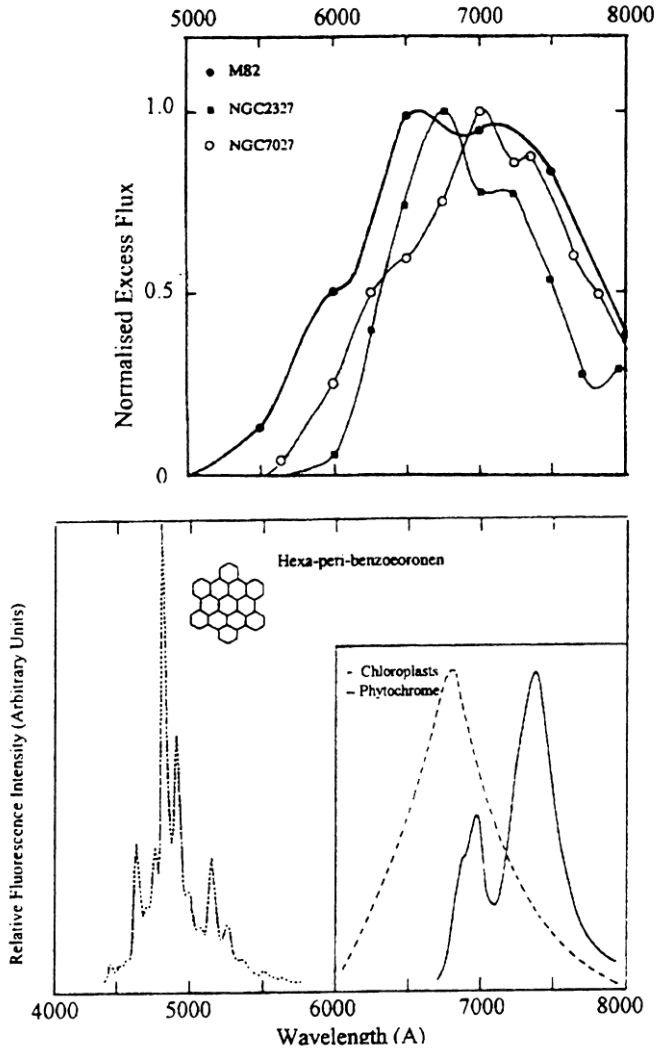

Fig. 1 The points in the top panel show the normalised excess flux over scattering continua from data of Furton and Witt (1992) and Perrin *et al.* (1995). The bottom right panel (inset) shows relative fluorescence intensity of spinach chloroplasts and phytochrome at a temperature of 77 K

The points in the top panel of Fig.1 show the normalized excess flux (over scattering continua) from data of Furton and Witt (1992) and Perrin *et al.* (1995). The bottom left panel is the fluorescence spectrum of hexa-peri-benzocoronene. The bottom right panel shows relative fluorescence intensity of spinach chloroplasts at a temperature of 77 K. The dashed curve is the relative fluorescence spectrum of phytochrome. From these comparisons it is clear that a biological explanation of the ERE phenomenon is both viable and preferable to any contrived non-biological explanation.

A recent analysis of HST observations showing red emission from the nebula NGC7023 by Witt et al (2006) have led to further uncertainties of its carrier (see Fig. 2). The standard view is that this is a nebula rich in inorganically derived PAH's (polycyclic aromatic hydrocarbons) is in serious difficulty in our view.

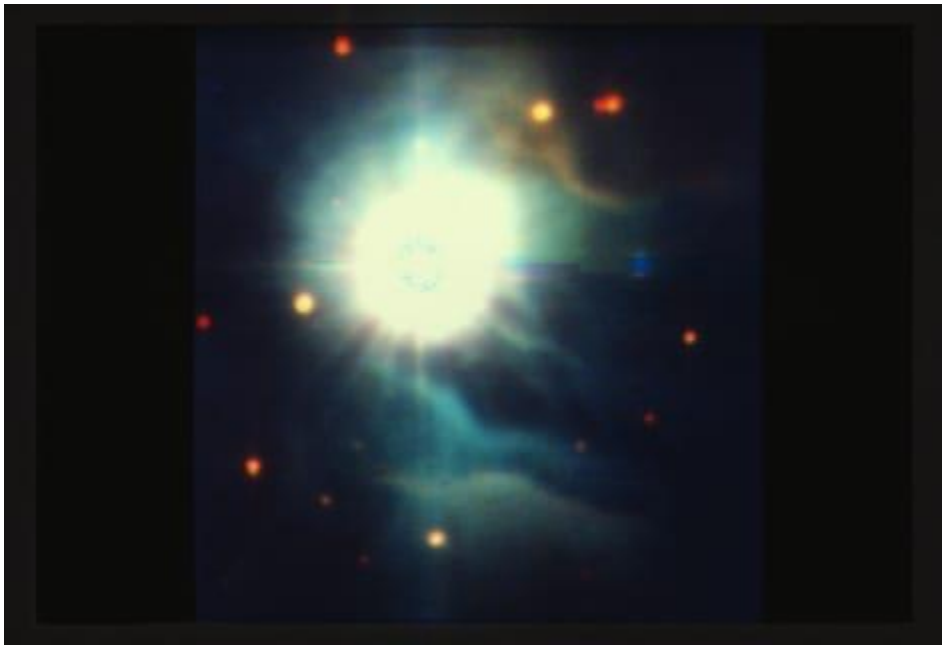

Fig. 2. Nebula NGC7023 showing red emission from an unidentifiable source

An alternative biological model for galactic ERE emission may be provided by studies of the red rain that fell in 2001 in Kerala, India and in 2012 in Sri Lanka. The red colour of this rain was found to be due to an unidentified microscopic organism containing a red pigment. The red rain cells in the Kerala rainfall are, incidentally, very similar to the cells recovered in the red rain of Sri Lanka some 11 years later, and the striking possibility remains that they form a component of interstellar and cometary dust.

Fig. 3. Location of the red rain event in Kerala, India, 2001

Spectroscopic/fluorescence studies of the red rain have shown features that are in remarkable agreement with the ERE phenomenon (12, 13, 14). For excitation wavelengths between 412 nm and 600 nm three features show up at the wavelengths 670, 763 and 823 nm as shown in Fig.4 (12, 13).

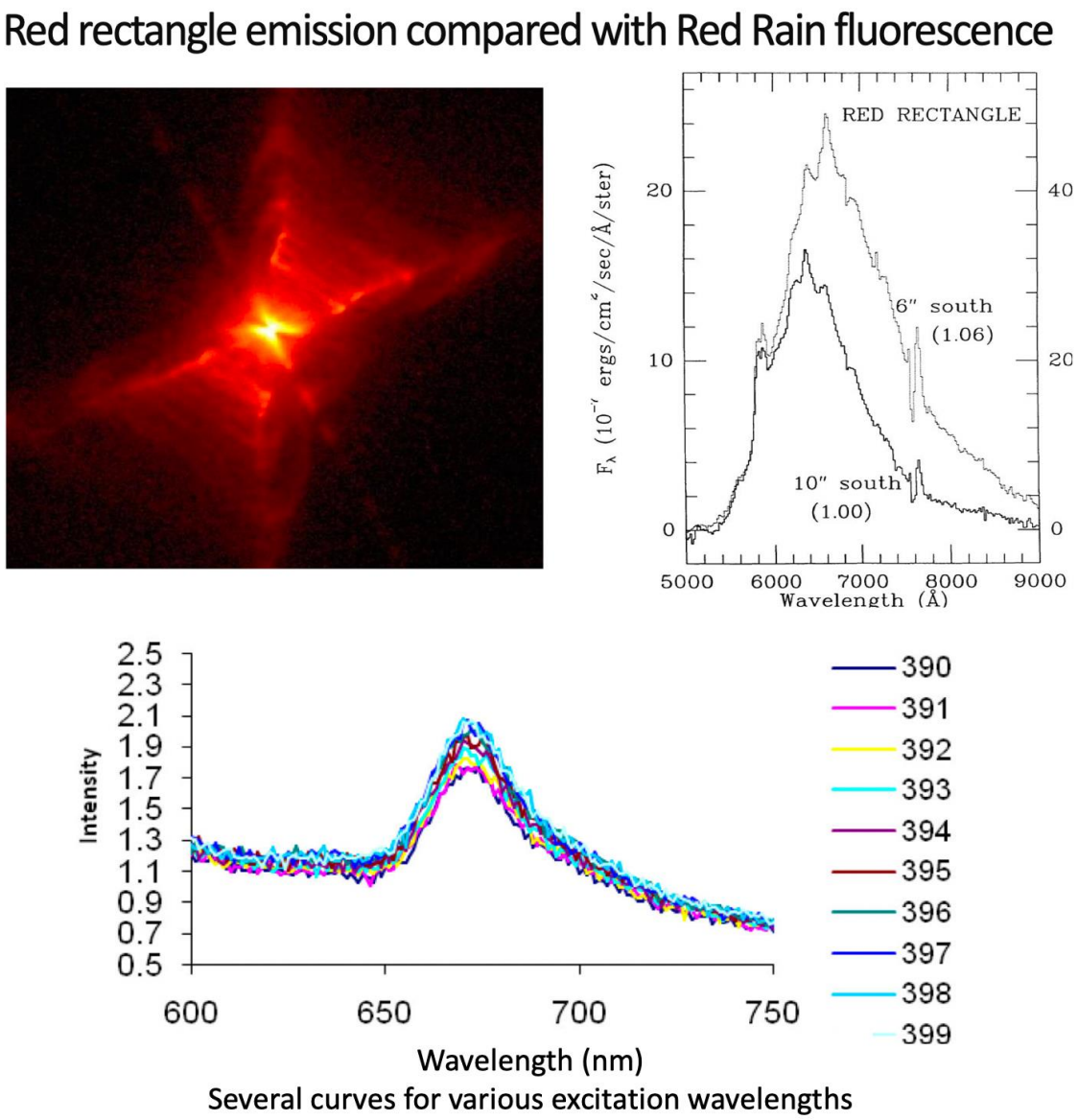

Fig.4. Emission spectra of red rain particles at different excitation wavelengths (412-600 nm) bottom curve.

We conclude by observing that this is yet another instance where the universe has its say – biology trumps over non-biology in accounting for the ERE phenomenon - the most startling manifestation perhaps being in observations of the Red Rectangle.

In this article, as well others in Vol. 30 and in earlier volumes of the *Journal of Cosmology*, the authors have clearly demonstrated that the detritus of biological life, together with pristine genetic components from which life is built, is distributed throughout the cosmos. In another article we have also argued that from the latest data obtained from the James Webb telescope, life seems to be widely distributed throughout a universe that is eternal and infinite.

In 2006 NASA scientists reported the discovery of the amino acid glycine, a fundamental building block of proteins, in the samples of comet Wild 2 returned by NASA's Stardust spacecraft. This was one of a long list of spectroscopic matches

with microbial material that were discovered both in interstellar and cometary dust from 1984 to the present day.

But what of the incredible range of lifeforms that are the result of assembly of the infinity of "genetic maps" that are cosmically dispersed throughout space in the form of bacteria and viruses? Astronomical and biological evidence, in our view, continues to point decisively against the long-held concept of the spontaneous generation of life. Bacteria and viruses are an all-pervasive component of a possibly eternal cosmos; they carry new genes mostly lodged within cometary-type bodies. Such cosmic genes rain down on planets like Earth, initiating life and thereafter augmenting it to unravel a magnificent cosmic life spectacle.

The break-up of bacteria, viruses, and the detritus of life, that are dispersed throughout the vast dust clouds of space shows up in a wide range of astronomical phenomena. These include the Diffuse Interstellar Bands (DIB's), PAH's and the extended red emission (ERE) discussed in the present paper.

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