A ROUND TABLE ON SCIENCE , LETTER AND ART

NIC'S CORNER

FROM THE STARS TO THE MIND

Speculation on the chemistry of interstellar black matter

Key words: melanins, fullerene, cosmoids, cosmochemistry, X-rays, LASER, black particles, interstellar matter, Bok globules.

Black matter is found universally, especially in the amorphous state. All the black matter known to date, from the lithosphere and biosphere to the cosmos, generally has the same chemical and physical properties. These include electron paramagnetic resonance (EPR); electrical properties; changes in surface properties under the effects of an electric field; the X-ray diffraction spectrum [1]; sensitivity to radiation inducing photo-ionization and photolysis [2]; explosion and fragmentation under the effects of LASER, pyrolysis, or fast atom bombardment [3-5]. The physical properties of black particles, and some of the chemical ones too, do not depend on the structure and nature of the melanogen.

An extensive polyconjugated radical-polaronic system can be found in all pigments, known as Little's spine [6]. The atoms are arranged in hexagons or pentagons, which are assembled in sandwiches in layers 3.4Å apart, like graphite in the open form, or giant fullerenes in the closed form. Black material has certain striking chemical properties: it is sensitive to H_2O_2 and halogens, it irreversibly loses CO_2 and H_2O on heating; it can bind organic products, drugs, ions and gas. From many viewpoints the melanins resemble activated charcoal in their chemical-physical behaviour.

Radioastronomy has shown there are organic molecules in the black dust clouds in the Milky Way.

Some of these molecules are very simple, like acetonitrile, or acetylene systems like the polyines.

Acetylene molecules like HC_5N, HC_7N, and HC_9N have been detected by spectroscopic analysis. Giant red stars also emit enormous amounts of carbon dust into the surrounding space, suggesting there may be some links between the acetylene structures and the soot formation [7, 8]. This implies that interstellar space may look black not just because of the lack of light, or because strong gravitational fields prevent light escaping [9], but also because of the presence of black matter in the solid state.

This matter would be in continual transformation under the action of radiation.

Graphite, which is found in interstellar space, breaks up under the action of LASER rays in a setting simulating certain parts of the cosmos, producing a series of fullerenes [7b], including the well-known C_{60}. LASER light also fragments black particles and melanin. The LASER in mass spectrometry (MALDI-TOF) does not give molecular peaks for melanin, but there are subproducts which might be interesting in cosmochemistry [5].

The figure 1 shows a photograph of dark interstellar clouds among the nebulae crowding the constellation of the Centaurus. These clouds, known as "Bok globules", are normally associated with protostellar formation [10, 11].

The photography is of great interest because it represent the "time" of Earth formation.

Figure 1

These dark clouds in space may contain black particles formed from benzene structures or heterocyclic polycondensate, like terrestrial melanins. More than 100 different molecules have been found in the space: H_2 and CO being among the most abundant; molecules like CH_3NH_2, CH_3OH, CH_3CH_2OH, HC_6CN, HC_9N, HNCO, CH_3CN, CH_2CHCN, CH_2CO, H_2CO, HCNS, CS, COS, CH_3SH, CH_2S, acetylene, ethylene, methane, silane, acetylene compounds, polycondensed aromatic systems, hexamethylenetetamine (HMT), porphyrins, microdiamonds, amorphous carbon [7, 12, 13, 16] and graphite [9, p.630]. The different molecules might be partly produced by the explosion of polycondensate systems like those shown in Figure 2, similar to the laboratory procedures for pyrolysis or atom bombardment [4].

Sulphated and oxygenated molecules might come, similarly, from thiophene or furane systems.

Figure 2

Mixtures of these materials are found in tars; they are made up of hexagonal and pentagonal rings and (except for pyrrole black) are little-known electrical conductors [14] on account of difficulties in isolating and purifying them. Spectroscopic and spectrophotometric analysis of these material is a potentially useful way of investigating cosmochemistry and interstellar black matter.

It is generally acknowledged that biological evolution followed on the heels of molecular chemical evolution, and this has led to the proposal that there was probably some synthesis of porphyrin-like substances in prebiotic times [15]. The presence of porphyrin-like sites [1b] in the melanins suggests that the black particles found on the earth had some sort of catalytic role, in symbiosis with metals.

Compared to minerals they would be ideal candidates for a prototype structure in the pre-enzymatic

era (stereospecific sites, clathrates, ability to bind metals, photoprotection, etc.). The black particles
may also have played a part in forming the primordial atmosphere on earth on account of their ability
to trap and release gases (in a giant fullerene "cage-like" structure?).

Black particles in general are an interesting feature in the evolution of interstellar and biological matter. They are conductors, which means they can transfer electrical charges from inside molecular
clouds, regulating their chemistry and the ion-radical-molecule equilibria. These properties can be
deduced from the absorption, polarization of stellar light and spectra of the infrared light emitted by
dust [9, 12]. The black particles might also have played a part in prebiotic evolution as atom and molecule assembly structures, or as generators of other molecular structures that have been annihilated. The shock waves produced by the supernovae might have the effect - like interstellar
particles when they move faster than 25 km/second - of making the black particles in space explode.

High-speed ions can cause fragmentation, and mixtures of simple products form. Some of the simple
organic molecules found in black clouds [12] are also among the products of pyrolysis and fast atom
bombardment of sepiomelanin, melanin from hair, tyrosine-melanin, serotonin-melanin, and tryptamine-melanin [4]. The following compounds have been identified: CH_4, CO_2, H_2O, HCN, CH_3Cl,
CH_3OH, C_4H_8, C_2H_6, COS, CH_3CHO, CH_3SH, C_4H_{10}, H_2S, CH_3CN, C_3H_6, methylcyclohexene, pyridine,
toluene, methylpyrrole, ethenylbenzene, phenol, benzoic acid, phenylester, benzaldoxime, 2,3-dimethylcyclohexanol, 1,2-benzoisothiazol, benzaldehyde, methylindole. The Stardust, Space Technology 4/Champollion, and Rosetta space missions should transmit analytical data on black dust
in the years 2005, 2006 and 2013 [16] so we should then have more details. The information presented here, together with whatever we find out from studying terrestrial black matter (tar, melanin, synthetic black) could be helpful in analysing the samples collected in the various missions.

Chemists see interstellar black matter as having aromatic and polycondensed heterocyclic structures,
some of them similar to substances known on earth. Under the action of radiation black matter explodes,
forming smaller fragments that are easier to identify. Black matter is in continuous evolution, producing
low-molecular-weight organic molecules as it changes that eventually become ice. As an electrical
conductor, black can regulate the chemistry and the balance of ions, radicals and molecules within
interstellar clouds. Black matter helps shield organic matter from radiation. The basic energy for organic
synthesis - heat, ionizing radiation, ultraviolet radiation - comes from the stars. The smallest fragments
resulting from the explosion of black matter probably give rise to organic molecules similar or identical to
some already known on earth.

The cosmochemistry of black matter may stimulate fresh interest on earth in research on the

melanins, which so far has strayed along the wrong paths. Once we have straightened out problems of
purification and extraction [17], further interesting developments can be expected in nanochemistry,
nanobiochemistry and nanophysics of these black particles [5, 18-26].
Melanin is a conductor whose configuration varies under the action of electric or electromagnetic
fields. Melanin assembles the simplest elements and can control the form and function of cell adhesion [18, 19]. Stellar melanin is a producer of organic molecules, while terrestrial melanin assembles organic molecules and macromolecules.

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