From Elemental Carbon to the Formation and Radiation Stability of Chiral Molecules

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C_{60} was detected for the first time in space in 2010 in the circumstellar medium (in certain protoplanetary nebulae) but also in the interstellar medium (for example in reflection nebulae). Actually C_{60} is the largest molecule known in the space. C_{60} once ejected in the interstellar medium can condense together with water and other ices in dense molecular clouds. Under the action of high energy radiation C_{60} reacts with the free radicals generated from the matrix where it is embedded [1]. If C_{60} is trapped in water ices it is hydroxylated and oxidized by the radiolysis products of water. The oxidation of C_{60} makes this molecule hydrophilic and hence soluble in water, while before hydroxylation C_{60} is completely insoluble in water. The same phenomenon occurs in water/ammonia, in water/methanol and in water/ammonia/ methanol mixtures [1]. Thus, C_{60} which in the solid state displays a considerable radiation resistance [2], when embedded in radiolytic sensitive matrices like those just mentioned, it reacts swiftly, it is solubilized and consequently its carbon content becomes available for abiotic processes of synthesis of other molecules of astrobiological interest [1]. Once elemental carbon is transformed into a soluble form, then the irradiation of interstellar ices leads to the formation of amino acids [3-6] which could be in enantiomeric excess if the irradiation occurred with circularly polarized light [7,8].

Our interest was focused on the radiolytic stability of amino acids once buried in comets or asteroids. First we have studied the radiolytic stability of all proteinogenic amino acids [9-13]. More recently, a series of non-proteinogenic amino acids, most of them found quite commonly in the meteorites known as carbonaceous chondrites, were subjected to solid state radiolysis in vacuum to a total radiation dose of 3.2 MGy corresponding to 23% of the total dose expected to be taken by organic molecules buried in asteroids and meteorites since the beginning of the solar system 4.6×10^9 years ago [14-16]. It is shown that an important fraction of each amino acid is able to “survive” the massive dose of radiation, while the enantiomeric excess is partially preserved [14-16]. Based on the results obtained, it is concluded that it is a surprise to find amino acids even in enantiomeric excess in carbonaceous chondrites.

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