Amino acids from photo- and thermo-processing of extraterrestrial ices: a possible source for further prebiotic chemistry

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Abstract

Laboratory experiments that simulate the photo- and thermo-processing of extraterrestrial ices always lead to the formation of semi-refractory organic residues [1,2]. These residues can be considered as laboratory analogs for the primitive organic matter incorporated into comets and asteroids. Many specific organic molecules have been detected in them [3,4]. Here we focus on amino acids because of their possible relevance to further prebiotic chemistry on Earth. We compare the amino acid content and distribution measured in organic residues produced in our experiments to those observed in CM chondrites presenting an increasing degree of aqueous alteration [5], a process thought to impact amino acid chemistry.
Moreover, the discovery of meteoritic amino acids with chiral asymmetry (enantiomeric excesses of the left form) has suggested that extraterrestrial organic materials may have contributed to prebiotic chemistry and directed the initial chiral asymmetry that further led to homochirality of amino acids on living organisms [6]. A proposed mechanism for the origin of chiral asymmetry in meteoritic amino acids involves an asymmetric photochemistry of extraterrestrial ices by chiral (left or right circularly polarized) UV light [7]. We have performed the asymmetric synthesis of amino acids on extraterrestrial ice analogs and measured the induced enantiomeric excesses [8].

We present our experimental results and discuss their astrophysical implications. These results support the idea of a general formation process for amino acids from photo- and thermo-processing of extraterrestrial ices as an important source for the inventory of amino acids in the early solar system.

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