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The Expected Dominance of Biotic and Abiotic L-Chirality on Mars and in the Solar System

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The generally accepted premise has been that abiotic synthesis of amino acids and sugars would result in a racemic mixture, thus, detection of an excess of D or L enantiomers on planets such as Mars would point to a biological origin. This premise is founded on the fact that terrestrial life requires homochirality to allow for functional structures involving proteins, amino acids, sugars and nucleic acids. The origin of this homochirality for terrestrial life has been an on-going debate since its discovery. Of the many proposed hypotheses for its existence on Earth, one may also have significant implications for the presence of a dominate chirality on Mars and other planets in the solar system.

Carbonaceous chondrite meteorites have been shown to contain an excess of non-terrestrial L-amino acid enantiomers. In order to explain this mixture, it has been suggested that it may result from the destruction of one enantiomer over the other due to exposure to energetic polarized photons either in the molecular cloud during solar system formation or afterwords. Experimental studies have shown that exposure of a racemic mixture of amino acids to right circularly polarized UV (CPUV) light of < 230nm wavelength results in enrichment of L-amino acids.

Several types of astronomical objects have been identified as sources for CPUV light, including, pulsers (rotating neutron stars and synchrotron nebula), magnetic and polar white dwarfs, and reflection nebulae. Two of these sources, reflection nebula and magnetic white dwarf binaries, are capable of producing 50% of their output as CPUV. However, in the former, CPUV is easily produced by on-going magnetic alignment of dust particles in addition to initial star formation with organic molecules present.

If astronomical asymmetry drives enantiomer asymmetry, then the delivery of abiotic non-racemic amino acids can be accomplished either through; (1) formative solar matter, remnant dust, meteorite, comets, etc.; or (2) direct on-going irradiation of exposed surfaces. In either case, we would expect the initial distribution of chirality to be similar on all planetary bodies within our solar system. In the case of abiotically produced organics, we would expect L-amino acids and D-sugars to be more prevalent on Mars. We would also expect any extinct or extant life on Mars to be based on L-amino acids and D-sugars as on Earth.

The dominance of homochirality on Earth has been recently shown to be due to a small excess of CPUV generated L-alpha-methyl amino acids that not only participate in synthesizing L-amino acids, but the small L preference is amplified to give L/D ratios of over 90% for both amino acids and sugars. For life on Mars, the same reaction pathways would most likely be operative and similar amplification would be present. The prevalence of CPUV generated L-dominance for both abiotic and biotic synthesis, strongly suggests the presence of non-racemic chirality on Mars.