Cracking the origins of life's asymmetry: Guiding the quest for biosignatures in space

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The exclusive preference for L-amino acids in proteins and D-sugars in nucleic acids is a key feature of life. Still, the origin and evolution of biological homochirality remain unresolved. Abiotic L-enrichments of amino acids in carbonaceous chondrites provide a strong hint that life's homochirality originated beyond Earth.[1] This, however, hinders the identification of biosignatures of putative past life in space. Would a detection of a set of enantioenriched amino acids on Mars point to traces of extinct life blurred by years of racemisation, or would it merely be a product of abiotic physico-chemistry operating in harsh extra-terrestrial environments? Cracking the origin of chiral imbalance in the Solar System remnants and the evolution of life's homochirality will aid in answering this question. To date, stellar ultraviolet circularly polarized light (UV CPL) has been recognized as one of the promising candidates for triggering symmetry breaking in interstellar environemnts.[2] Monochromatic UV CPL has proven capable of inducing enantiomeric excesses in amino acids via asymmetric photolysis,[3-5] as predicted by their anisotropy spectra. While these are important proof of concept experiments, to validate the *astrophysical CPL scenario*, comparisons of the net effect of broadband CPL with the results of enantioselective analyses of extra-terrestrial samples are necessary. I will outline how a strategic selection of analytes can provide useful insights into the *CPL scenario*. Here, our latest results on isovaline will be presented,[6] which ultimately provide a sound explanation for its enantiomeric excess detected in carbonaceous chondrites that has been extensively discussed in the origin-of-life research community over the last two decades. Furthermore, the question of the origins of homochirality of membrane phospholipids will be addressed. Our recently recorded anisotropy spectra of membrane lipids and their chiral backbones[7] provide a guideline for future enantioselective analyses of interstellar ice analogues as well as meteorites and return samples.

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