Photochemical synthesis, chirality and detection of the building blocks of life

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What is responsible for the emergence of life's homochiral biopolymers – DNA/RNA and proteins – where all the constituent monomers exhibit the same *handedness*?

Based on *in-situ* observations and laboratory studies, we propose that this handedness occurs when chiral biomolecules are synthesized asymmetrically through interaction with circularly polarized light (cpl) in interstellar space.[1] Previous experimental results on the asymmetric photolysis of amino acids,[2] as well as the absolute asymmetric synthesis from achiral interstellar ice precursor molecules,[3] revealed polarization- and energy-controlled induced enantiomeric enrichments.

Our recent research has shown that the central chiral unit of RNA, ribose, forms readily under simulated comet conditions (**Fig. 1**) and this has provided new insights into the accessibility of precursors of genetic material in interstellar environments.[4] The significance of our research arises due to the current lack of experimental demonstration that amino acids and sugars can simultaneously and asymmetrically be synthesized by a universal physical selection process. In my presentation, I will therefore highlight a few significant results on our on-going cometary ice simulation experiments, the chiroptical properties of targeted sugar and amino acid molecules in the UV using circularly polarized synchrotron light and present future strategies towards furthering understanding the origin of asymmetric prebiotic molecules.

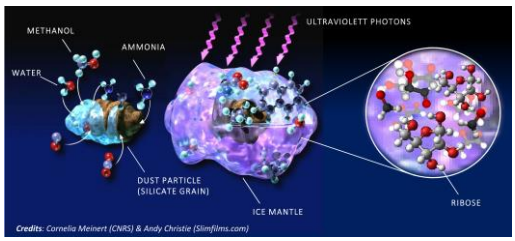

Fig. 1. Ribose forms in the icy mantles of interstellar dust grains from simple precursor molecules (water, methanol, and ammonia) under high energy radiation.

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[1] C. Meinert et al., *Phys. Life Rev.* **8**, 307 (2011).

[2] C. Meinert et al., *Angew. Chem. Int. Ed.* **53**, 210 (2014).

[3] P. de Marcellus et al., *Astrophys. J. Lett.* **727**, L27 (2011); P. Modica et al., *ApJ* **788**, 79 (2014).

[4] Meinert C. et al., *Science* **352**, 208 (2016).