Why nature never makes chiral twins – insights from chiroptical spectroscopy and extra-terrestrial sample analyses

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Abstract: 'How did life choose its handedness?' Just like our hands mirror each other, but cannot be superimposed on each other, amino acids and sugars exist in left- and right-handed forms. Even if there appears to be no biochemical reason to favor one enantiomer over the other, life on Earth uses almost exclusively left-handed amino acids and right-handed sugars. This is called biological homochirality and it is inevitable for building functional proteins and RNA/DNA. Numerous experiments have confirmed that simple prebiotic molecules could have been synthesized both in space as well as on the early Earth. However, the preferential selection of one enantiomer over the other remains to date most likely explained by asymmetric interactions of stellar ultraviolet circularly polarized light (UV CPL) with chiral organics. The astrophysical origin of homochirality is strengthened by i) the detection of l-enriched amino and d-enriched sugar acids in meteoritic samples, ii) the detection of CPL in several star-forming regions as well as iii) experiments studying the interaction of UV CPL with prebiotically relevant chiral species. In this talk, I will highlight significant results on our on-going cometary ice simulation experiments (**Fig. 1**) as well as on circular dichroism and anisotropy spectroscopy as a key tool to decipher the response of chiral molecules to UV CPL. Moreover, I will present our major findings on recent asymmetric photosynthesis/photolysis experiments to discuss whether stellar UV CPL could have induced a common chiral bias across molecular families?

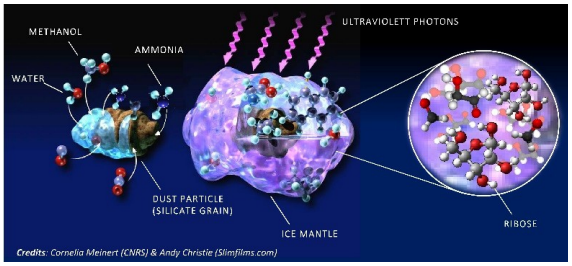

Figure 1: Ribose forms in the icy mantles of interstellar dust grains from simple precursor molecules (water, methanol, and ammonia) under high energy radiation.