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

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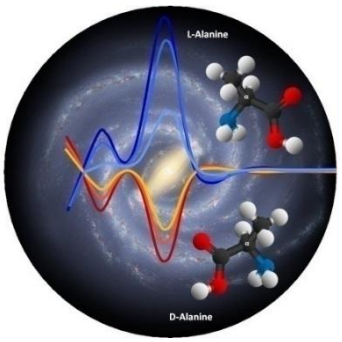
'*How did life choose its handedness*?' Just like our hands mirror each other, but cannot be superimposed on each other, amino acids and sugars exist in left- and right-handed forms. Even if there appears to be no biochemical reason to favor one enantiomer over the other, life on Earth uses almost exclusively *left-handed* amino acids and *right-handed* sugars. This is called biological homochirality and it is inevitable for building functional proteins and RNA/DNA.
Several asymmetric processes have been experimentally tested to induce chirality in molecular systems, but those focusing on stellar circularly polarized light (CPL) appear to us to be most encouraging, especially given results reported on CPL-induced chirality in amino acids. 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[1] as well as on circular dichroism and anisotropy spectroscopy[2] 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?



Selection of molecular handedness at the dawn of molecular cloud evolution.

1. C. Meinert *et al.*, *Science* **2016**, *352*, 208; A. M. Turner *et al*. *Sci. Adv*. **2019**, *5*, eaaw4307.

2. J. Bocková *et al*. *Commun. Chem*. **2021**, *4*, 86; C. Meinert *et al*. *Nat. Commun*. **2022**, *13*, 502.

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