Ion collisions with clusters of amino acids: Investigating the origin of life

Clusters constitute a class of nano and subnano material exhibiting the properties of both free particles (atoms or molecules) and solids. Molecular clusters exist in nature, especially in the atmosphere. Interestingly, the seminal experiment of Miller and Urey in 1953 aiming at simulating the conditions of Earth's early atmosphere to test whether organic molecules could be created abiogenically, i.e. formed from chemical reactions occurring between inorganic molecules, showed that amino acids were the first biomolecules that could be produced. A natural question is to understand the role of amino-acid clusters in the formation of larger biological molecules such as peptides.

Recently, we have demonstrated that ion collisions [1] and photoexcitation [2] can induced reactivity inside of clusters of molecules thus playing a role in the molecular complexity. In particular, we have shown that it is possible to form polypeptide after the collision of α particles with clusters of β-alanine amino acids [1]. Here the "soft" interaction of low-energy ions plays a pivotal role avoiding the dissociation of transient reactive species.

Ion collisions with gas-phase clusters will be used to probe the amino-acid clusters. Using the ion beams delivered by ARIBE the low-energy ion beam facility of GANIL (Caen), it is possible to softly ionise clusters by electron capture from the incoming projectile. Moreover, one can change the amount of energy deposited in the system by changing the projectile [3]. Amino acids clusters will be produced by a gas aggregation cluster source. The products of the interaction will be analysed using coincidence time-of-flight mass spectrometry.

Complementary studies will be performed at SOLEIL, the French national synchrotron. These experimental studies are part of an emerging collaboration with groups in Spain and Israel and can be the base of further work in the group.

References:

[1] P. Rousseau et al., *Nature Comm.* **11** (2020) 3818.

[2] O. Licht et al., *Angewandte Chemie Int.* Ed. **62**, e202218770 (2023)

[3] E. Erdmann et al., *Phys. Chem. Chem. Phys.* **23** (2021) 1859.

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