**Laboratory experiments to understand the molecular complexity of astrophysical environments**

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Complex organic molecules are detected in the gaseous and solid phases of molecular clouds and protoplanetary disk. The origin of these molecules is still debated, but a large part is supposed to form on the surface of frozen grains. These icy grains, observable in dense molecular clouds, will be altered by highly energetic processes (VUV photons, ions, electrons) during the formation of planetary systems. These alterations allow the activation of molecules initially present in these ices, resulting in the development of a significant chemical reactivity. In certain environments such as the solar nebula, these grains can be heated, releasing in the gas phase a large part of the complex organic molecules initially formed on the surface or within the ice bulk. Some of these molecules can also react inside the ice forming nonvolatile molecules that remain on the grains leading to the formation of refractory organic residues. Part of the transformed grains can then agglomerate, resulting in interplanetary objects such as comets or asteroids. As a result, some of the organic matter present in solar system objects could come be inherited from ices found in dense molecular clouds.

On the basis of laboratory experiments, we develop an analytical strategy to study the chemistry generated by the processing of such ices during simulated solar system formation. We particularly demonstrated the richness of molecules formed in refractory organic residues [1]. We also investigated the composition of the gas phase depending of the initial composition of the ice [2] as well as the molecular composition of the refractory organic residues [3,4]. Finally, we demonstrated how this matter can evolve inside asteroids, parent bodies of meteorites in our solar system [5]. Overall, our analyses show that this ice chemistry leads to the formation of all building blocks needed to start a prebiotic chemistry on telluric planets.

All results obtained from these experiments suggest that ices of astrophysical objects are key environments to generate a rich molecular diversity, as it could be for our solar system, and question the role of this exogenous reservoir in the emergence of life on Earth.

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