Reactivity in interstellar ice analogs : role of the structural evolution

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The synthesis of interstellar complex organic molecules in ice involves several types of reactions between molecules and/or radicals, which are usually considered to be diffusion controlled [1]. We aim to understand the coupling between diffusion and reactivity in the interstellar ice mantle, using a model binary reaction in the diffusion-limited regime.

We performed isothermal kinetic laboratory experiments on interstellar ice analogues at low temperatures, using the NH_3:CO_2:H_2O model system we previously reported [2] where reactants NH_3 and CO_2 have a low reaction barrier and are diluted in a water-dominated ice.

We found that in the diffusion-limited regime, the reaction kinetics is not determined by the intrinsic bulk diffusivity of reactants. Instead, reactions are driven by structural changes evolving in amorphous water ice, such as pore collapse and crystallization. Diffusion of reactants in this case likely occurs along the surface of (tiny) cracks generated by the structural changes [3].

The reactivity driven by the structural changes breaks the conventional picture of reactant molecules/radicals diffusing in a bulk water ice. This phenomenon is expected to lead to a dramatic increase of the production rates of interstellar complex organic molecules in star forming regions.

Références

[1] Ghesquière, P. et al., *PCCP, (*2015)
[2] Noble, J. A. et al., *PCCP*, (2014)
[3] Ghesquiere, P. et al., A&A, *in press*, (2018)