Evolution of organic molecules in space: From ice deposition to organic residues

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Organic molecules derived from ice that formed in the interstellar medium (ISM) are among the potential building blocks of our solar system and could be the precursor of a part of the organic matter found in comets and meteorites (e.g. [1]). However, it is not clear how the organic ice formed in the ISM may have evolved through temperature increase and irradiations by UV-photons and cosmic rays until their incorporation into the solar system. Recently, N_2 was detected in the Jupiter family comet 67P/Churyumov-Gerasimenko made by the ROSINA mass spectrometer aboard the Rosetta spacecraft. Its abundance relative to CO, lower than solar, argues for a very low temperature formation of the cometary ice [2]. Thus, tracking the evolution of organic and water ices with temperature could have significant implications regarding to the cometary ice behavior in the current context of the ROSETTA mission.

The laboratory experimental apparatus PICACHU (*Photochemistry in Interstellar Cloud for Astro-Chronicle in Hokkaido University*) was recently developed to simulate the formation and evolution of organic ice through UV irradiation and heating under ISM conditions. Typical ISM gases (H_2O, CO, NH_3, CH_3OH) are deposited onto the three faces of a refrigerated substrate (~12K) and simultaneously irradiated by UV under ultra-high vacuum. Gases, desorbed from the ice during heating and post-irradiation, are monitored by a quadrupole mass spectrometer (QMS) in the vacuum chamber. The morphological evolution of the ice deposits during warm-up and/or irradiation are observed *in situ* using a stereo microscope and correlated with desorbed gases measured by the QMS. The final organic residues obtained after warm-up and/or post-irradiation are characterized using *ex situ* observational and analytical instruments. Porous membrane-like textures are well as aggregates of round particles of some tens of nanometers are observed in the residues but differ according to the irradiation conditions. Detailed observations and implications will be discussed at the meeting.

[1] Tielens A. G. G. M. (2013) *Rev. Mod. Phys.* **85**, 1021–1081. [2] Rubin M. et al. (2015) *Science, 10.1126*.