Pluto, a distant cousin of the primitive Earth ?

Lora Jovanović*[1], Thomas Gautier[1], Véronique Vuitton[2], Cédric Wolters[2], Jérémy Bourgalais[1], François-Régis Orthous-Daunay[2], Ludovic Vettier[1], Laurène Flandinet[2], and Nathalie Carrasco[1]

[1]Laboratoire Atmosphères, Milieux, Observations Spatiales (LATMOS) – Université de Versailles Saint-Quentin-en-Yvelines : UMR8190, Sorbonne Universite : UMR8190, Centre National de la Recherche Scientifique : UMR8190 – 11, boulevard d'Alembert - Quartier des Garennes 78280 Guyancourt, France

[2]Institut de Planétologie et d'Astrophysique de Grenoble (IPAG) – Centre National de la Recherche Scientifique : UMR5274, Université Grenoble Alpes : UMR5274 – 414, rue de la Piscine BP 53 38041 Grenoble Cedex 9, France

Abstract

The presence of liquid water and organic molecules is a *sine qua non* condition for life to appear (Cottin et al., 2015). Liquid water is an important requirement for habitability, because of its exceptional solvent qualities allowing organic chemistry to occur and organic molecules and biological structures to be stable (Brack, 1992, Lammer et al., 2009). Organic matter can be of exogenous or endogenous origins (Chyba and Sagan, 1992). Exogenous origin includes delivery of organic molecules by extraterrestrial objects, such as comets or meteorites, while endogenous origin consists in organic synthesis in hydrothermal vents or in the atmosphere of the primitive Earth.
In 1953, Miller showed that the production of amino acids is possible in a reducing gas mixture composed of methane CH4, ammonia NH3, water H2O and molecular hydrogen H2 exposed to an electric discharge. Likewise, discharges carried out in a gas mixture composed of ammonia NH3, carbon monoxide CO and water H2O produced nucleobases (Ferus et al., 2017). On a planetary scale, the study of Titan revealed that its atmosphere made of molecular nitrogen N2 and methane CH4 is the place of a complex photochemistry producing a huge variety of complex organic molecules which may include chemical species of astrobiological and prebiotic interest (Sagan et al., 1992, Trainer et al., 2006, Raulin et al., 2012).

Can Pluto be considered as a distant cousin of the primitive Earth ? Can the study of Pluto's atmosphere provide constraints on our understanding of the primitive atmosphere of the Earth ?

Pluto is an icy dwarf planet owning a tenuous atmosphere composed of variable proportions of molecular nitrogen N2 and methane CH4 with 515 $\pm$ 40 ppm of carbon monoxide CO (Lellouch et al., 2017, Young et al., 2018). This reduced atmosphere is the place of production of photochemical aerosols, that were observed at least as high as 350 km of altitude in Pluto's atmosphere on July 14th, 2015, during *New Horizons* flyby (Stern et al., 2015, Gladstone et al., 2016, Cheng et al., 2017).

*Speaker

As Hörst et al. (2012) detected amino acids and nucleotide bases in the solid products of a dusty N2:CH4:CO plasma, the question of the prebiotic interest of Pluto's aerosols is legitimate. Hence, we produced Pluto's aerosol analogues in the PAMPRE experiment developed at LATMOS (Guyancourt, France) and we analyzed their chemical composition by high-resolution mass spectrometry (ESI+/Orbitrap technique) at IPAG (Grenoble, France). Our study has evidenced that the analogues are composed of a wide variety of complex, heavy, unsaturated organic molecules constituted of carbon, hydrogen, nitrogen and oxygen atoms, essential elements of life. At m/z 111.043, the chemical formula C2H5N3O was detected and may correspond to the cytosine, the easiest produced nucleobase (Jovanović et al., submitted for publication).