Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

BAO001-P02 Room: Convention Hall Time: May 24 17:15-18:45

Formation of nucleobases and related compounds from the UV irradiation of pyrimidine in mixtures of astrophysical ices

Michel Nuevo[1*], Stefanie N. Milam[2], Scott A. Sandford[1], Jamie E. Elsila[2], Jason P. Dworkin[2]

[1]NASA Ames Research Center, USA, [2]NASA Goddard Space Flight Center, USA

The formation of complex organic molecules including compounds of astrobiological interest has been studied most extensively in the last 10 years via laboratory experiments simulating astrophysical environments. These experiments have, for example, shown that amino acids, the monomers of proteins, can be formed under interstellar or cometary conditions from the vacuum UV photo-irradiation at low temperature of interstellar ice analogs containing H_2O, CO, CO_2, CH_3OH, NH_3, etc.[1-3] Although the presence of amino acids in the interstellar medium (ISM) has not been unambiguously confirmed[4,5], they are present in meteorites,[6] indicating that biomolecules and/or their precursors can be formed in extraterrestrial environments. Similarly, nucleobases, the informational subunits of DNA and RNA, have been detected in meteorites,[7-9] but have not been observed in the ISM.[10] In this experimental work, we study of the formation of pyrimidine-based organic compounds from the UV irradiation of pyrimidine ($C_4H_4N_2$) mixed with ices containing H_2O, NH_3, and/or CH_3OH in various proportions at 20-30 K. Pyrimidine is the heterocyclic parent structure for the nucleobases uracil, cytosine, and thymine. Our results show that the UV irradiation of pyrimidine mixed with such ices leads to the formation of a large number and variety of pyrimidine derivatives, including the nucleobases uracil[11] and cytosine.[12] The photo- and thermo-stability of pyrimidine and its photo-products in these ices will also be discussed, as well as their mechanisms of formation.[13]

References:

1. Bernstein, M. P., et al., Nature, 416, 401 (2002).
2. Munoz Caro, G. M., et al., Nature, 416, 403 (2002).
3. Nuevo, M., et al., Orig. Life Evol. Biosph., 38, 37 (2008).
4. Kuan, Y.-J., et al., Astrophys. J., 593, 848 (2003).
5. Snyder, L. E., et al., Astrophys. J., 619, 914 (2005).
6. Sephton, M. A., Nat. Prod. Rep., 19, 292 (2002).
7. van der Velden, W. and Schwartz, A., Geochim. Cosmochim. Acta, 41, 961 (1977).
8. Stoks, P. and Schwartz, A., Nature, 282, 709 (1979).
9. Martins, Z., et al., Earth Planet. Sci. Lett., 270, 130 (2008).
10. Charnley, S. B., et al., Adv. Space Res., 36, 137 (2005).
11. Nuevo, M., et al., Astrobiology, 9, 683 (2009).
12. Milam, S. N., et al., in preparation.
13. Bera, P. P., et al., in preparation.

Keywords: Interstellar medium, Ices, Nucleobases, UV irradiation