From Interstellar Ices to Polycyclic Aromatic Hydrocarbons
A symposium to honor Lou Allamandola's Contributions to the Molecular Universe
Annapolis, MD, USA - September 13th to September 17th, 2015

Detection of aldehydes and sugars in laboratory simulated astrophysical ices: astrochemical and prebiotic significance

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The photo/thermochemical evolution of laboratory ices of astrophysical interest is currently performed in our laboratory. The detection of numerous (26) amino acids has already been reported (Meinert et al, 2012) and the production of small enantiomeric excesses in similar experiments using ultraviolet circularly polarized light from synchrotron radiation (de Marcellus et al, 2011; Modica et al, 2014) shows the potential for such ices to become of importance not only in astrochemistry but also for prebiotic chemistry. In a series of experiments, using exactly the same protocol (similar ice mixtures, similar photon dose) we have produced organic residues and searched for specific molecules, namely sugars. Only the analytical methods used for their detection differs from those used for amino acids' detection since no hydrolysis of the sample is required and different derivatization methods are necessary.

We have detected, for the first time to our knowledge, ten aldehydes in our residues and, among them, two sugars (or precursors), glycolaldehyde and glyceraldehyde (de Marcellus et al, 2015). These two sugars were considered as precursors for ribose. However, ribose in a specific environment where liquid water is present, is not stable. Recently, Powner, Gerland and Sutherland (2009) have proposed a prebiotic scenario in which glycolaldehyde and glyceraldehyde, if present in a primitive ocean, may bypass the production of ribose and allow the direct formation of ribonucleotide, a potential serious precursor for the formation of RNA.

Besides this hypothesis, our experimental results do show that, in the same material produced by the same method (ices and photo/thermochemistry), we are able to provide at the same time amino acids, precursors of oligopeptides, and sugars, precursors of ribonucleotides. The prebiotic significance of this kind of experiments is thus quite suggestive although there remains much to understand the path of such specific molecules to self-organization leading to the formation of proteins and RNA molecules.

REFERENCES

de Marcellus, P., Meinert, C., Nuevo, M., Filippi, J.J., Danger, G., Deboffle, D., Nahon, L., Le Sergeant dHendecourt, L. and Meierherich, U.J. Astrophys.J. Letters, (2011), 727, L27-L32
de Marcellus, P., Meinert, C., Mygrodoska, I, Nahon, L., Bushe, T., Le Sergeant dHendecourt, L. and Meierhenrich, U.J., (2015), PNAS, 112, 965 - 970
Meinert, C., Filippi, J.J., de Marcellus, P., Le Sergeant dHendecourt, L. and Meierhenrich, U.J. (2012), Chem.Plus Chem, 77, 185 - 191
Modica, P., Meinert, C., de Marcellus, P., Nahon, Meierhenrich, U.J. and Le Sergeant dHendecourt, L., (2014), Astrophys.J., 788, 79 - 89
Powner, M.W., Gerland, B., and Sutherland (2009), Nature 459, 239 - 242