Artificial comet contains building blocks of life

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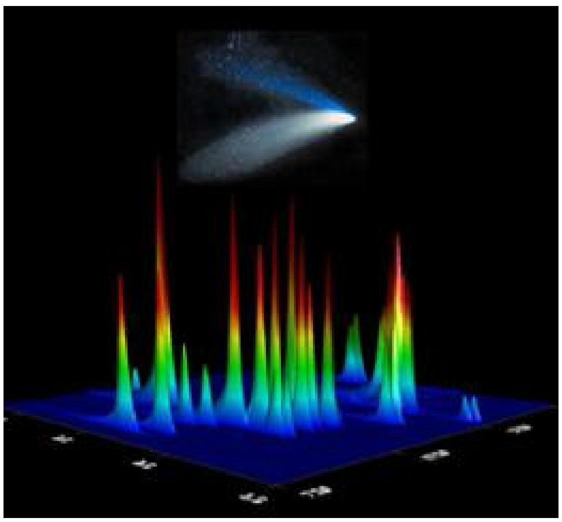

Chromatogram of the cometary ice obtained using the multidimensional gas chromatograph. Each peak corresponds to an amino acid. The higher the peak, the greater is the amount of amino acid present in the sample. *ChemPlusChem*, 77 (2012). Credit: Wiley-VCH GmbH & Co

The first molecules of life form naturally in comets, reveals a French-German study led by Uwe Meierhenrich and Cornelia Meinert at the Institut de Chimie de Nice and by Louis Le Sergeant d'Hendecourt at the Institut d'Astrophysique Spatiale (CNRS/France). The researchers produced an artificial comet and, using a technique that is the only one of its kind in the world, they analyzed its chemical composition. For the first time ever, it appeared that comets may contain molecules that made up the earliest genetic material: diamino acids. At the interface of chemistry, biology and astrophysics, this work lends support to the hypothesis that the basic building blocks of life did not appear on Earth but in space. These findings have just been published in the journal *ChemPlusChem*.

The research forms part of the major European space mission 'Rosetta'. The program aims to place a lander on the comet Churyumov-Gerasimenko to study the composition of its nucleus. In a bid to anticipate Rosetta's findings, the scientists decided to create an artificial comet, or 'simulation of interstellar/cometary ice', and analyze its composition.

The team led by Louis Le Sergeant d'Hendecourt was in charge of creating a micro-comet at the Institut d'Astrophysique Spatiale. Under extreme conditions similar to those found in space (-200 °C and in a vacuum), the researchers condensed a number of compounds found in the interstellar medium, such as water (H_2O), ammonia (NH_3) and methanol (CH_3OH) molecules, onto a solid piece of magnesium fluoride (MgF_2), while subjecting them to ultraviolet radiation. After ten days, they obtained a few precious micrograms (10^{-6} grams) of artificial organic material.

This material was then analyzed at the Institut de Chimie de Nice by a team led by Uwe Meierhenrich and Cornelia Meinert, using high-performance technology: a multidimensional gas chromatograph (GCxGC/TOF-MS). This device, which was installed in Nice in 2008, can detect ten times more molecules in a sample than a traditional one-dimensional chromatograph.

This technology enabled the chemists to identify twenty-six amino acids in the artificial comet, while previous international experiments had only detected three. More important still, they discovered something no one had ever witnessed: six diamino acids, including, in particular, N-(2-aminoethyl)glycine. This is an extraordinary breakthrough, as this compound might be one of the major constituents of the peptide nucleic acid (PNA) molecule, which is the precursor of terrestrial DNA.

These key results show that the first molecular structures of life may have formed in the interstellar and cometary media, before reaching the early Earth via falling meteorites and comets.

The next step will be to determine the conditions of pressure, temperature, pH, etc under which the N-(2-aminoethyl)glycine might then have formed PNA. To undertake this new project, the researchers have already initiated a collaboration program with two large teams, one from the US and the other from the UK.

More information: N-(2-Aminoethyl)glycine and Amino Acids in Interstellar Ice Analogues; Cornelia Meinert, et al., *ChemPlusChem*, online 29 February 2012.

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