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# Stability and alteration of amino acid-related compounds against soft X-rays and extreme UV in interplanetary space

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Prebiotic organic matters such as amino acids have been found in extraterrestrial bodies. It was suggested that they were formed in cold space environment, and were delivered to the early Earth. Interplanetary dust particles (IDPs) were promising carriers since they could deliver organics safer than large meteorites or comets. On the other hand, IDPs are so small that they are directly exposed to the solar radiation, which may decompose or alter organic molecules in IDPs. In the present study, we evaluated the stability of amino acid-related compounds against soft X-rays and extreme ultraviolet light (EUV): Irradiation was performed at NewSUBARU BL-06 (Univ. Hyogo), and the irradiation products were analyzed by several methods including HPLC and XANES.

Five amino acid-related samples - Glycine (Gly), hydantoin (Hyd: precursor of glycine), isovaline (Ival), 5-Ethyl-5-methylhydantoin (EMHyd: precursor of isovaline) and complex organic compounds synthesized by proton irradiation of a mixture of CO, $NH_3$ and $H_2O$ (referred to as CAW) - were irradiated with continuous light from soft X-rays to IR (hereafter referred as to soft X-rays) at NewSUBARU BL-06 (University of Hyogo) under high vacuum condition. After collecting the irradiated sample with pure water, we measured the recovery ratio of each compound by using ion exchange or reversed-phase HPLC systems. In some cases, $CaF_2$ window was used to cut soft X-rays and EUV (referred as to VUV irradiation; cut-off wavelength is ca. 130 nm).

Amino acids or their precursors were gradually decomposed by soft X-rays irradiation, and water-insoluble organics were formed. The amino acid precursors (Hyd, EMHyd, CAW) were much more stable than the free amino acids (Gly, Ival) against soft X-rays. Thus, we could suggest that the precursor amino acids are likely to present more stable than free amino acids in space environment such as meteorite surface and in IDPs. Neither racemization nor formation of glycine was observed even after 99 % of the initial L-alanine was decomposed.

When $CaF_2$ window was used, little insoluble matters were formed. Thus, soft X-rays (including EUV) are responsible for the formation of insoluble organics. Soft X-rays fraction in the solar radiation is small in the present time, but it is supposed that the strong X-rays were emitted from the young Sun before the formation of planetesimals. It should be examined the possible formation of insoluble organic matter, that is now found in carbonaceous chondrites and comets, by the irradiation with high-energy photons from the young Sun.

Keywords: amino acids, amino acid precursors, synchrotron radiation, soft X-rays, interplanetary space, origins of life