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Formation, alteration and delivery of interstellar organics: Verification with experiments on ground and in space

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As a wide variety of organic compounds have been found in meteorites and comets, their relevance to the origin of life is discussed. Many kinds of amino acids have been identified in extracts of carbonaceous chondrites, their origin is controversial. Possible carriers of organic compounds to the Earth were meteorites, comets and interplanetary dust particles (IDPs). It is said that IDPs could deliver organics more safely than meteorites and comets, the nature of organics in IDPs are little known since they have been collected usually in terrestrial biosphere. In addition, IDPs are directly exposed to cosmic and solar radiation, which might destroy organics in IDPs.

When possible interstellar media (a mixture of carbon monoxide or methanol, ammonia and water) was irradiated with high-energy particles, amino acid precursors were formed in high energy yields. We are planning to irradiate possible interstellar media with high energy heavy ions from a newly developed Digital Accelerator in KEK to confirm it. It suggested that amino acid precursors could be formed in interstellar space in prior to the formation of the solar system. Before the incorporation of interstellar organic compounds into comets or parent bodies of meteorites, they could be altered with high energy photons from the yound Sun. Soft X-rays irradiation of simulated interstellar organics resulted in the formation of hydrophobic compounds as seen in comets.

We are planning a novel astrobiology mission named Tanpopo by utilizing the Exposed Facility of Japan Experimental Module (JEM/EF) of the International Space Station (ISS). Two types of experiments will be done: Capture experiments and exposure experiments. In the exposure experiments, organics and microbes will be exposed to the space environments to examine possible alteration of organic compounds and survivability of microbes. Selected targets for the exposure experiments of organic compounds are as follows: Amino acids (glycine and isovaline), their possible precursors (hydantoin and 5-ethyl-5-methyl hydantoin) and complex precursors (CAW) synthesized from a mixture of carbon monoxide, ammonia and water by proton irradiation. In capture experiments, we will collect space dusts by using ultra-low density silica gel (aerogel), and will analyze them after returning them to the Earth. Amino acid enanthiomers will be analyzed after HF digestion and acid hydrolysis, as well as characterization of complex organic compounds in space dusts. The mission is planned to be started in 2015.

Keywords: origins of life, interstellar organic compounds, cosmic rays, interplanetary dust particles, Tanpopo Mission, particles irradiation