DL or not DL, that is a historical problem: Which is the predominant amino acids in exogenous complex organics ?

Yoshinori Takano[1]; Kensei Kobayashi[2]; Katsumi Marumo[3]

[1] AIST Central 7, MRE; [2] Dept. Chem. Biotech., Yokohama Natl. Univ.; [3] AIST, GSJ

http://staff.aist.go.jp/takano.yoshinori/

Since the time of Pasteur, the development of specific chirality in terrestrial biomolecules has remained one of the most important problems with regard to chemical evolution. Numerous theories regarding the origins of homochirality have been presented, from both biotic and abiotic viewpoints. Meteorites, specifically carbonaceous chondrites, carry abiotic records of the early organic chemical evolution of the solar system. Successful detection of enantiomeric excess of amino acids in the Murchison meteorite is indicative of an asymmetric influence on organic chemical evolution before the origin of life.

The presence of extraterrestrial non-racemic amino acids leads to a persuasive scenario for the exogenous origins of homochirality. Recent studies have documented the optical counterpart of an isolated neutron star. From a photochemical point of view, continuous circularly polarized light (CPL) from Supernovae, which are elliptically and ultimately circularly polarized, may be a possible origin of biomolecular asymmetry. Several investigations have attempted to examine the asymmetric photolysis of free amino acids. Simulation experiments suggest, however, that not free amino acids, but complex organic compounds containing amino acid precursors are formed in interstellar environments. Only trace amounts of amino acids were detected among the products of simulation experiments before hydrolysis. In interstellar environments, CPL photolysis of racemic free amino acids, as has been performed in previous works, is simply not plausible. Here, we report the first absolute asymmetric photosynthesis of enantiomeric alanine precursors using CPL.

The possible asymmetric formation of amino acids from complex organic compounds in extraterrestrial environments has been examined. A gaseous mixture of carbon monoxide, ammonia and water, which have been identified among interstellar media, was irradiated with 3.0 MeV protons in order to obtain complex organic compounds. The synthesized products of amino acid precursors were then irradiated with right (R-) and left (L-) continuous ultraviolet circularly polarized light (UV-CPL) obtained from a synchrotron radiation (SR) source. A wide variety of amino acids including glycine and alanine were identified in the hydrolysates of the resulting products: RCPL preferentially photosynthesized D-alanine, and LCPL yielded more L-alanine.

Statistically significant enantiomeric excesses (% D - % L) of +0.44 % (P below 0.05) and -0.65 % (P below 0.002) were obtained by RCPL and LCPL, respectively. These results imply that the origins of chirality in chemical evolution may be attributable to asymmetric formation of amino acid precursors from extraterrestrial organic compounds following the origin of life.