Viva Origino 33 (2005) 41－172

S1-2

TERRESTRIAL PROOF FOR THE EXTRATERRESTRIAL ORIGIN OF HOMOCHIRALITY ON EARTH. CIRCULARLY POLARIZED SYNCHROTRON RADIATION PHOTOLYSIS OF ALIPHATIC AMINO ACIDS IN WATER AND IN ICE AT VARIOUS TEMPERATURES

Yoshihisa Inoue,[1] Hideo Nishino[1], Masahito Hosaka[2], and Masahiro Katoh[2]

[1]*Entropy Control Project, ICORP, JST 4-6-3 Kamishinden, Toyonaka 565-0085, Japan*

[2]*UVSOR Facility, Institute for Molecular Science, Myodaiji-cho, Okazaki 444-8585, Japan*

E-mail: inoue@chem.eng.osaka-u.ac.jp

The homochirality that ubiquitously exists in natural biological substances on Earth is a long-standing enigma. To explain this, Bonner proposed an extraterrestrial origin hypothesis about two decades ago that the homochirality originated from the irradiation of racemic amino acids by circularly polarized light (CPL) emitted from electrons circulating a neutron star at near the speed of light like a huge synchrotron (such a process is called "absolute asymmetric synthesis (AAS)" in chiral photochemistry). In 1990, Engel et al. indeed found optically active alanine (Ala) of 18% enantiomeric excess (ee) in the organic mantle of the Murchison meteorite, and Cronin et al. also found enantiomerically enriched natural and non-natural aliphatic amino acids of 1-9% ee in Murchison and other meteorites. More recently, the star-forming region was shown to emit circularly polarized infrared radiation. Nevertheless, the Bonner's intriguing hypothesis have not seriously been proved or even examined experimentally.

In our recent study, we demonstrated that the AAS of aliphatic amino acids efficiently proceeds in aqueous solution at various pH upon right- and left-handed CPL generated by a polarizing undulator installed in an electron storage ring. The photodecomposition mechanism and products were shown to critically depend on the solution pH, affording glycine as a common product from Val, leucine, and isoleucine (but not from Ala) through the γ-hydrogen abstraction by n,π*-excited ester carbonyl, i.e. the Norrish Type II mechanism, at acidic pH. In contrast, the corresponding α-hydroxycarboxylic acid was produced through deamination at neutral and basic pH. In either case, the remaining amino acids were enantiomerically enriched as expected. We further examined the synchrotron CPL-induced AAS of the same amino acids in ice at temperatures down to 21 K. The results will be presented in the lecture.