ASTROPHYSICAL SCENARII FOR THE ORIGIN OF BIOMOLECULAR ASYMMETRY PROBED BY CIRCULARLY-POLARIZED VUV SYNCHROTRON RADIATION. L. Nahon[1], M. Tia[1], B. Cunha de Miranda[1], S. Daly[1], G. Garcia[1], C. Meinert[2], U. Meierhenrich[2], I. Myrgorodska[2], P. de Marcellus[3], P. Modica[3] and L. Le Sergeant d'Hendecourt[3]
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Synchrotron radiation appears to be a very valuable tool for experimental astrophysics able to simulate the VUV spectrum of light (including Lyman-α) encountered in the interstellar medium and planetary ionospheres. This is especially the case of the DESIRS beamline [1] at SOLEIL providing an intense, tunable, high resolution, VUV radiation with controlled polarizations, including Circularly Polarized Light (CPL).

This last characteristic allows the study of several asymmetric photon-induced processes which could be part of an abiotic astrophysical scenario linked to the origin of life's homochirality, the fact for instance that only L-amino acids are found in proteins in the biosphere. Assuming an extra-terrestrial formation of building blocks of life such as amino-acids, a possible abiotic explanation for the selection of the L-enantiomers could be the exposure to CPL as an asymmetric bias during their journey towards Earth, inducing some enantiomeric excess (e.e.), that are indeed observed in some amino acids in primitive carbonaceous meteorites, that could then be amplified on Earth.

After an introduction to Synchrotron Radiation, Circularly Polarized Light and chirality, asymmetric photon-induced processes leading to noticeable e.e. on amino-acids will be described:

(i) The photon wavelength-controlled enantioselective photolysis of racemic amorphous solid-state films on the alanine amino acid leading to e.e. of up to 4 %,[2] as measured by 2D-GCMS techniques, in direct connection with anisotropy spectra recorded on similar samples.[3]

(ii) Photochirogenesis on CPL-irradiated interstellar achiral ice analogs (H_2O, NH_3, CH_3OH) leading to the asymmetric production of several amino acids with e.e. up to 2.5 % for alanine, and with the same e.e. sign for all amino acids at given wavelength. These photon-energy dependent excesses reverse sign by swapping the light helicity, showing a chirality transfer from photon to matter (Curie Principle).[4]

(iii) Photoelectron Circular Dichroism on gas phase alanine [5] an asymmetric photoemission process observed as an intense asymmetry of the ejected electrons and therefore of the corresponding amino-acid recoiling ion, leading in a given light of sight to an e.e. of up to 4 % at the Lyman α wavelength.[6]

References:

[1] Nahon L. et al. (2012), *J. Synchrotron Rad. 19*, 508-520. [2] Meinert C. et al. (2014), *Angew. Chem.-Int. Edit. 53*, 210-214. [3] Meinert C. et al. (2012), *Angew. Chem.-Int. Edit. 51*, 4484-4487. [4] Modica P. et al. (2014), *Astrophysical Journal 788*, 79. [5] Tia M. et al. (2014), *J. Phys. Chem. A 118*, 2765-2779. [6] Tia M. et al. (2013), *J. Phys. Chem. Lett. 4*, 2698-2704.