**CHIRAL PHOTONS AS TRIGGER OF LIFE'S HANDEDNESS?** C. Meinert[1,2], S. V. Hoffmann[3], N. C. Jones[3], L. Nahon[4], P. de Marcellus[5], P. Modica[5], L. le Sergeant d'Hendecourt[1,5] and U. J. Meierhenrich[2], [1]CNRS, France, Email: cornelia.meinert@unice.fr; [2]Institut de Chimie de Nice, UMR 7272, Université de Nice Sophia Antipolis, 06108 Nice, France, [3]ISA, Department of Physics & Astronomy, Aarhus University, 8000 Aarhus, Denmark, [4]Synchrotron SOLEIL, 91192 Gif-sur-Yvette, France, [5]Institut d'Astrophysique Spatiale, UMR 8617, Université Paris Sud, 91405 Orsay , France

**Introduction:** All life on Earth is characterized by its asymmetry – both genetic material and proteins are composed of homochiral monomers. Understanding how this molecular asymmetry initially arose is a key question related to the origins of life. Cometary ice simulations, L-enantiomeric enriched amino acids in meteorites and the detection of circularly polarized electromagnetic radiation in star-forming regions point to a possible interstellar/protostellar generation of asymmetrically biased molecules *via* asymmetric photolysis and/or *photo*synthesis processes in the icy mantles of dust grains [1].

**Results:** Here we report the asymmetric synthesis of amino and diamino acids from an astro-physically relevant achiral ice mixture containing methanol, water, and ammonia by means of circularly polarized synchrotron irradiation. With advanced analytical techniques [2], the asymmetrical formation of up to five amino acids with a maximum enantiomeric excess (*ee*) of up to 2.54% [3, 4] has been revealed.

The induced *ee* is determined by the anisotropy factor $g$, defined by $\Delta\varepsilon/\varepsilon$, the ratio between the differential extinction coefficient $\Delta\varepsilon$, and the extinction coefficient $\varepsilon$. In order to better understand the chiral symmetry breaking of amino acids formed under simulated interstellar/circumstellar conditions we recorded circular dichroism (CD) [5] and anisotropy spectra (**Fig. 1**) of amino acids [6] yielding new and intense CD transitions and $g(\lambda)$ in the range between 130 and 350 nm.

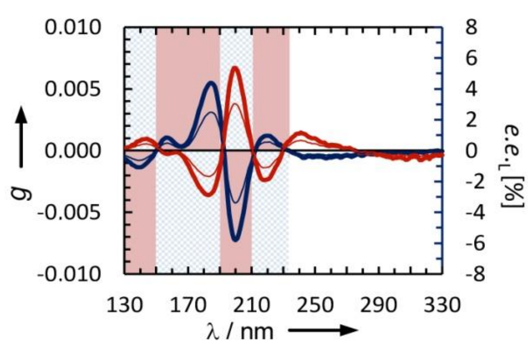


**Fig. 1** Anisotropy spectra $g(\lambda)$ of enantiopure L-alanine (blue) and D-alanine (red) in the VUV spectral range (thick lines) condensed as isotropic amorphous films. Thin lines represent the predicted L-enantiomeric excess $ee_L$ induced by either *left* or *right*-CPL as a function of $g$ and preselected value of the extent of the reaction of $\xi$ 99.99%.

The anisotropy spectra obtained for amino acids in the isotropic solid phase show well-resolved zero-crossings, extrema, and $g$-values up to 0.024. These data allow a) the prediction of the sign of the induced *ee*, b) the determination of kinetics and *ee*–values of enantioselective photolysis, and c) the selection of the CP light wavelength best suited for inducing enantioenrichment.

Based upon our recorded anisotropy spectra, we subjected amorphous films of racemic $^{13}$C-alanine to far-UV circularly polarized synchrotron radiation to probe the asymmetric photon-molecule interaction under interstellar conditions (**Fig. 2**). Optical purities of up to 4 % were reached, which correlate with our theoretical predictions [7]. Importantly, we show that chiral symmetry breaking using circularly polarized light is dependent on both the helicity and the wavelength of incident light

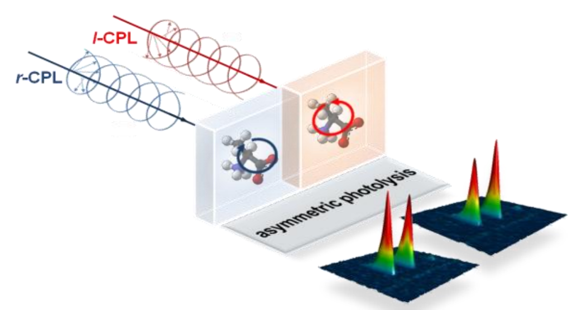


**Fig. 2** Energy-tunable asymmetric photolysis of Ala.

The formation of enantiomer-enriched amino acids within pre-cometary ice analogues, as well as the chiroptical properties of amino acids in the solid state, should serve as a means towards furthering understanding the origin of asymmetric prebiotic molecules.

**References:**

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