

Optical anisotropy emergence in bioorganic compounds with polarized synchrotron radiation

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The origin of homochirality in terrestrial bioorganic compounds is one of the most mysterious issues in the study of the chemical evolution of life. To experimentally clarify the emergence of structural anisotropy in bioorganic compounds both in solid-phase, we measured the optical anisotropy of amino acid films on substrate surfaces, after they had been excited by a physically asymmetric excitation source; namely linearly polarized ultraviolet light. As the sample of solid-phase molecules, we formed thin solid films of racemic phenylalanine on a silica substrate by deposition from crystal powders of DL-phenylalanine using a vacuum evaporator. To clarify the optical anisotropy of the films, we measured the circular dichroism (CD) spectra of the deposited films using a spectropolarimeter. The CD spectra of the film exhibited no peaks. To introduce asymmetry into the film, we irradiated it with intense linearly polarized light (LPL) introduced from synchrotron radiation. After the irradiation with the LPL, new broad peaks appeared in the CD spectra. The intensity and the sign of the peaks changed with the sample rotation angle with respect to the optical axis of the spectropolarimeter. This result shows that a new construction presenting linear birefringent was introduced in the film, suggesting that the amino acid molecules in the soft material were oriented to the direction of dipole polarization induced by the LPL. The emergence of anisotropy in bioorganic molecules after irradiation with polarized lights is effective enough to demonstrate asymmetric reactions on the surfaces of such space materials as meteorites or interstellar dust, which will reveal the origins of terrestrial homochirality prior to the existence of life.