Near-infrared Imaging Circular Polarimetry of the Orion Nebula using IRSF telescope with SIRPOL and Implications for the Origin of Homochirality

FUKUE, Tsubasa (NAOJ)
TAMURA, Motohide (NAOJ / Graduate University for Advanced Studies)
KANDORI, Ryo, KUSAKABE, Nobuhiko (NAOJ)
HOUGH, James H. (University of Hertfordshire)
BAILEY, Jeremy (University of New South Wales)
WHITTET, Douglas C. B. (Rensselaer Polytechnic Institute)
LUCAS, Philip W. (University of Hertfordshire)
NAKAJIMA, Yasushi, HASHIMOTO, Jun (NAOJ)

The origin of biomolecular homochirality is a longstanding mystery. The terrestrial living material consists almost exclusively of one enantiomer, L-amino acids. Amino acids in several meteorites have been found to have enantiomeric excesses of the same handedness as that seen in biological amino acids. Such detection of enantiomeric excesses in meteorites is consistent with the hypothesis that terrestrial life was seeded by the delivery of organics from outer space during the heavy bombardment phase of early Earth. Enantiomeric excesses can be produced by circularly polarized light through asymmetric photochemistry.

We report a wide-field and deep near-infrared (K_s band: 2.14 μm) circular polarization image in the Orion nebula, where massive stars and many low-mass stars are forming[1]. We use SIRPOL on the IRSF 1.4 m telescope in South Africa for the polarimetry.

Our results reveal that a high circular polarization region is spatially extended around the massive star-forming region, the BN/KL nebula (Fig. 1). Significant circular polarization extends over a region about 400 times the size of the solar system. However, other regions show no significant circular polarization. Most of the low-mass young stars do not show detectable extended structure in either linear or circular polarization, in contrast to the BN/KL nebula.

Our results and the feature of the Orion nebula implies as follows: If our solar system formed in a massive starforming region and was irradiated by net circularly polarized radiation, then enantiomeric excesses could have been induced, through asymmetric photochemistry, in the parent bodies of the meteorites and subsequently delivered to Earth. These could then have played a role in the development of biological homochirality on Earth.

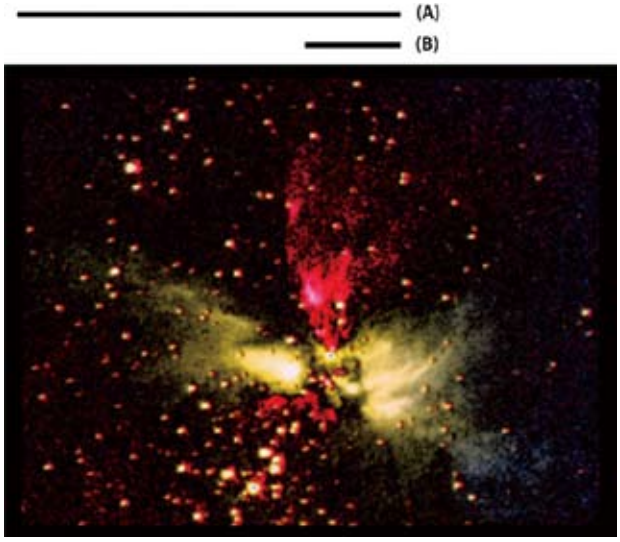

Figure 1: This image shows the degree of circular polarization of the Orion star-forming region. Yellow color expresses left-handed circular polarization, where the electric vector of light is rotated anticlockwise. Red color expresses righthanded circular polarization. The black bar denoted by (A) expresses about 400 times the size of the solar system, and the bar by (B) shows about 100 times the size of the Solar System.

Reference

[1] Fukue, T., Tamura, M., Kandori, R., Kusakabe, N., Hough, J. H., Bailey, J., Whittet, D. C. B., Lucas, P. W., Nakajima, Y., Hashimoto, J.: 2010, *Origins of Life and Evolution of Biospheres*, **40**, 335.