

Near-Infrared Image of Circular Polarization in the Orion Nebula

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We report a wide image of circular polarization (CP) in the Orion nebula. Near infrared circular polarimetry of the nebula was conducted using the SIRIUS camera [1] and its polarimeter (SIRPOL) on the 1.4-m IRSF telescope at the South African Astronomical Observatory.

The CP image in the K_s band (2.14 μm) reveals that a high CP region is spatially extended (~ 0.4 pc) around the massive star-forming region, the Orion Becklin-Neugebauer(BN)/Kleinman-Low(KL) nebula [2]. The degrees of CP range from +17% to -5% . On the other hand, other regions, including the linearly polarized Orion bar, show no significant CP, in contrast with the linear polarization (LP) image [3].

The detected degrees of CP are the highest among the previously observed young stellar objects (YSOs). To explore the production mechanism of CP in a YSO, we investigate correlations of CP, LP, and $H - K_s$ color, in the BN/KL region from the obtained images [4]. $H - K_s$ color representing extinction is well correlated with CP. We derive a simple relation between dichroic extinction, color excess, CP, and LP, assuming a model for a YSO with aligned non-spherical dust grains. The observed correlation between the Stokes parameters and the color excess agrees with the derived relation, and suggests a major contribution of dichroic extinction to the production of CP in this region.

From the viewpoint of astrobiology, our results also provide the implication for the origin of the terrestrial life. The terrestrial living material consists almost exclusively of one enantiomer, left-handed amino acids and right-handed sugars. The origin of biomolecular homochirality is a longstanding mystery that is critical to understanding the origin and development of life. Our result reveals that the significant CP extends over a region ~ 400 times the size of the solar system [2]. If our solar system formed in a massive star-forming region like the Orion nebula and was irradiated by CP radiation, then enantiomeric excesses could have been induced, through asymmetric photochemistry, in the parent bodies of the meteorites. These would be subsequently delivered to Earth, and could then have played a role in the development of biological homochirality on Earth.

References

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