Near-Infrared Circular Polarimetry of NGC 6334-V: The Origin of Circular Polarization

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Linear polarization is easily produced and widely observed in star-forming regions being produced by scattering from dust (resulting in reflection nebulae) and dichroic extinction of starlight by aligned grains. On the other hand, circular polarization is much less observed in star-forming regions, even though circular polarization can provide evidence for changing grain/field alignment directions along the line-of-sight and hence the presence of twisting fields. There are only five star formation regions with near-infrared circular polarimetric studies published in refereed journals. In this presentation, we present deep and wide circular polarization images of the NGC 6334 massive star-formation complex observed in the near-infrared bands. The observations were conducted with the unique *JHKs*-band simultaneous Polarimeter (SIRPOL) on the 1.4m IRSF telescope placed in South Africa. Our results of circular polarimetry observations show high degrees of circular polarization, as much as 22% in the Ks band, in the infrared nebula associated with the outflow. The circular polarization has an asymmetric positive/negative pattern and is very extended (0.65 pc). Both the high circular polarization and its extended size are larger than those seen in the Orion circular polarization region. Three-dimensional Monte Carlo light-scattering models are used to show that the high circular polarization may be produced by scattering from the infrared nebula followed by dichroic extinction by an optically thick foreground cloud containing aligned dust grains. Our results show not only the magnetic field orientation of around young stellar objects, but also the structure of circumstellar matter such as outflow regions and their parent molecular cloud along the line of sight. We also report our results of the first systematic near infrared circular as well as linear imaging polarimetry of 9 star forming regions covering from high-mass to low-mass stars. We have found that (1) the circular polarization is ubiquitous in star forming regions, (2) their degrees are very high (>~20 %) in massive star forming regions, (3) their spatial extension is extensive (~0.1 pc) in massive star forming regions, (4) there is a clear trend between the circular polarization degrees and the stellar masses, (5) the dichroic polarization of scattered light is most likely the origin of large circular polarization, and (6) these may support the circular polarization in star forming regions as an origin of the biological homochirality on Earth, as proposed for the Orion nebular.