Infrared Linear and Circular Polarimetry of the NGC 6334 Star Forming Region

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Abstract

Magnetic fields have been thought to play a crucial role in regulating accretion onto protostars, both in powering and shaping outflows and removing angular momentum from disk material, to allow the protostar to gain mass. However, the precise role of the magnetic field is poorly understood and evidence for its shape and structure has not been forthcoming. Getting evidence for the morphology of these fields has been tricky though - and this is an area in which polarimetry can help. There are two complementary methods for revealing magnetic fields in star forming regions. First, far-infrared/submillimeter thermal emission polarimetry - still very limited - to be more developed with SCUBA2, SOFIA, and ALMA. Second, near-infrared imaging polarimetry - Our unique and ongoing SIRPOL survey. In particular, circular polarization can provide evidence for changing grain/field alignment directions along the line-of-sight and hence the presence of twisting fields. However, the observational database of circular polarimetry in star forming regions is still very small. Orion that shows widespread circular polarization and high degree of polarization up to 17 % with a quadrupolar pattern is the sole sample of infrared circular imaging polarimetry in the massive star forming regions. In this presentation, we present deep linear and circular polarization images of the NGC 6334 massive star-formation complex observed in the near-infrared bands. Our result of linear polarimetry observations is consistent with that of previous linear polarimetry observations. The degree of linear polarization is up to ~60 % and the size of western nebula is ~35 arcsec. Our circular polarimetry is the first data in this region and the result shows that the degree of circular polarization is as higher as 20% with very clear, extended asymmetric pattern. It is the second case for the massive star forming regions and the clearest case that a non-uniform magnetic field structure has been inferred for a young stellar object at this spatial resolution using this technique. In other words, it is the first case of a distinct pattern with some asymmetry in the massive star forming regions here and now. This asymmetry pattern does not conform to the classical alternating symmetry seen in other objects and models. Therefore, our data, especially showing asymmetry, will be particularly important for current theoretical simulation. The degree of circular polarization up to 20 % is the highest circular polarization ever observed and the degree and size of the circular polarization in the NGC 6334-V region is comparable to the Orion circular polarization region. Using three-dimensional Monte Carlo light-scattering model, we reproduced asymmetry of circular polarization pattern showing high degree of circular polarization. From our results, we consider that a helical field may be a prominent component of the magnetic field threading through the NGC 6334-V outflow system. Based on our observational results and Monte Carlo simulations, we will discuss the origin of these polarizations and the relationship to the magnetic field in this region as well as the origin of homochirality.