Numerical simulation of radiative transfer for scattered light

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The wide-field (˜8' x 8') and near-infrared imaging polarimetry for some astronomical objects are being successfully obtained with the SIRIUS camera (Nagayama et al. 2003) and its polarimeter on the 1.4 m Infrared Survey Facility (IRSF) telescope in South Africa. The infrared bands consist of 1.25 micro m (J band), 1.63 micro m (H band), and 2.14 micro m (Ks band). For instance, near-infrared polarization images of the Orion Nebula were presented by Tamura et al. (2006). Their results by polarimetry have shown a very different view from ordinary imaging. Polarimetry observations are useful for a better understanding of circumstellar environments.

To extract more precisely the physical information on the environments from acquired polarimetry observations, we need a proper model of light scattered by dust and calculation of radiative transfer in a dusty environment. Therefore, we are developing a radiative transfer code by Monte-Carlo method. In addition, we are studying appropriate models for those observations. In the radiative transfer code, we consider photon's polarization status (e.g., Fischer et al. 1994), which is expressed by Stokes parameters (I, Q, U, V). Intensity is expressed by I. Linear polarization is expressed by Q and U. Circular polarization is expressed by V. We also calculate the optical property of scattering and absorbing matter, e.g., dust. This property is included into the radiative transfer code. At each scattering point, the photon's Stokes parameters are transformed according to the optical property of dust. We gather emerging photons toward an observer to draw intensity and polarization maps, and then we can compare the maps with observations. In this study, we discuss observable features of infrared scattered light by circumstellar dust.