Monte Carlo Radiative Transfer and Optical Property of Dust

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Using the SIRIUS camera [1] and its polarimeter on the 1.4 m Infrared Survey Facility (IRSF) telescope in South Africa, the wide-field (~8' x 8') and near-infrared imaging polarimetry for some astronomical objects are being successfully obtained. The infrared bands consist of 1.25 μm (J band), 1.63 μm (H band), and 2.14 μm (Ks band). For example, near-infrared polarization images of the Orion Nebula provided a significantly different view from ordinary imaging [2]. Polarimetry observations are useful for a better understanding of circumstellar dusty environments.

We need a proper model of light scattered by dust and calculation of radiative transfer in an ensemble of the dust, to extract more precisely physical information on the dusty environments from the above-mentioned polarimetry observations. Therefore, we are developing a radiative transfer code by the Monte-Carlo method and studying dust models appropriate to those observations. In the radiative transfer code, we consider photon's polarization status (e.g., [3]), 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 of arbitrary shapes. This optical property is incorporated in 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 that allow us to compare theoretical models with observations. In this study, we discuss observable features of infrared radiation scattered by circumstellar dust, considering the optical property of dust.

Keywords: radiative transfer; polarization; dust.

References

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