3D radiative transfer code for polarized scattered light with aligned grains

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Polarized scattered light has been observed in cometary comae[1] and in circumstellar disks[2]. It carries information about the grains from which the light scattered. However, modeling polarized scattered light is a complicated problem.

We are working on a 3D Monte Carlo radiative transfer code based on the code developed by Juvela & Padoan[3. It will incorporate hierarchical grid structure (octree) and the full Stokes vector for both the incoming radiation and the radiation scattered by dust grains. In octree grid format an upper level cell can be divided into 8 subcells by halving the cell in each of the three axis. Levels of further refinement of the grid may be added, until the desired resolution is reached. The radiation field is calculated with Monte Carlo methods. The path of the model ray is traced in the cloud: absorbed intensity is counted in each cell, and from time to time, the model ray is scattered towards a new direction as determined by the dust model.

Due to the non-spherical grains and the polarization, the scattering problem will be the main issue for the code and most time consuming. The scattering parameters will be taken from the models for individual grains. We can introduce populations of different grain shapes into the dust model, and randomly select, based on their amounts, from which shape the model ray scatters. Similarly, we can include aligned and non-aligned subpopulations of these grains, based on the grain alignment calculations, to see which grains should be oriented with the magnetic field (when present). The 3D nature of the grid allows us to assign these values, as well as density, for each cell, to model phenomena like e.g., cometary jets.

The code will record polarized scattered light towards multiple observer directions within a single simulation run. These results can then be compared with the observations of comets, or, in the case of other star systems, of circumstellar disks, to help us study these objects.

We will present tests of the code in development with simple models.

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