
Radiative transfer modelling of the interstellar medium

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Our understanding of astronomical sources is based mainly on radiation. This is true also in studies of the interstellar medium (ISM) where we observe the emitted, scattered, and extincted radiation from sources with a wide range of optical depths. The objects are typically extended clouds (diameters 1e14 m or more) of gas and dust where the properties of the ISM itself can be highly dependent on the radiation field. Our main interests are in the interactions of radiation with interstellar dust grains and with interstellar molecules, as they are observed at large scales.

The extinction, scattering, and thermal emission of interstellar dust are standard tools in the study of the structure of star-forming interstellar clouds. Conversely, the observations reveal an evolution in dust properties between diffuse clouds and dense, pre-stellar cores. I will describe some ongoing research on the modelling of dust scattering and emission. I will also discuss the challenges in the radiative transfer post-processing of magnetohydrodynamical models where the number of discrete volume elements is approaching one billion.

In the case of spectral lines, the basic radiative transfer methods are often simpler. This is because scattering (as a process changing the direction of photon propagation) can normally be ignored. On the other hand, the radiation changes the excitation state of the atoms and molecules, which again changes the optical depth of the medium. Therefore, more than in the case of dust studies, calculations may require a large number of iterations before an equilibrium solution is reached. I will discuss some of the methods that are used to control the noise of the solution and to speed up the convergence.