We study the reliability of mass estimates obtained for molecular cloud cores using sub-mm and infrared dust emission. We use MHD-simulations and radiative transfer to produce synthetic observations with resolution and noise typical of Herschel surveys. We estimate dust colour temperatures using intensity pairs or all five Herschel wavelengths, calculate column densities and compare estimated and true masses. We study also the influence of embedded heating sources. The shape, but not the position, of mass spectrum is reliable against observational errors and analysis biases. This changes only if cores have optical depths higher than in basic hydrostatic equilibrium. Observations underestimate spectral index $\beta$ when there are temperature variations along line of sight. A bias can be observed when true $\beta$ varies with wavelength. Internal heating sources produce inverse correlation between colour temperature and $\beta$ that may be difficult to separate from any intrinsic $\beta(T)$ relation of the dust grains.

**Results**

We investigated the effect of internal heating by adding protostellar sources to locate clumps in column density maps and derived the core mass and mass spectrum. We compared these results to Galactic studies that are being conducted with Herschel satellite and will be presented in Malinen et al. (2011). The present study is relevant to many Galactic studies that are being conducted with Herschel satellite and will be continued with the future high-resolution ALMA observations.

**Calculations**

We use two MHD model clouds, another with cores of moderate opacity (mass column density $10^{17}$ cm$^{-2}$) and another with cores of high opacity (maximum column density $10^{20}$ cm$^{-2}$). The size of both clouds is 10 pc. We calculated surface brightness maps of dust emission with our 3D radiative transfer program (Juvela & Padoan 2003; Lunttila et al. 2011) and used the model results to study the reliability of mass estimates obtained for molecular cloud cores using sub-mm and infrared dust emission. We used MHD-simulations and radiative transfer to produce synthetic observations with resolution and noise typical of Herschel surveys. We estimate dust colour temperatures using intensity pairs or all five Herschel wavelengths, calculate column densities and compare estimated and true masses. We study also the influence of embedded heating sources. The shape, but not the position, of mass spectrum is reliable against observational errors and analysis biases. This changes only if cores have optical depths higher than in basic hydrostatic equilibrium. Observations underestimate spectral index $\beta$ when there are temperature variations along line of sight. A bias can be observed when true $\beta$ varies with wavelength. Internal heating sources produce inverse correlation between colour temperature and $\beta$ that may be difficult to separate from any intrinsic $\beta(T)$ relation of the dust grains.

**Introduction**

The conditions in cold molecular cloud cores determine many fundamental aspects of star formation: stellar mass distribution, formation efficiencies, evolution timescales etc. In order to understand the early phases of star formation, we must study the cold cloud cores. The initial mass function (IMF) appears to be directly linked to the core mass function (CMF) of pre-stellar cores (Motte et al. 1998, 2001; Johnstone et al. 2000; Enoch et al. 2008). However, large temperature gradients and changes in dust emissivity could distort core mass estimates and even affect the shape of the derived core mass spectra. Also internal heating caused by protostars could affect the estimated mass spectra. We investigate these errors by comparing measurements from hydrodynamic (MHD) simulations and radiative transfer modeling of dust emission.

We present the results from a study using cloud models derived from MHD runs performed on hierarchical grids. With automatic mesh refinement (AMR) one can follow the evolution of individual cores much further (see Collins 2010) and, because of the stronger density and temperature variations, also the errors in the derived core masses may be larger. Our main interest is not in the shape of the CMF but in the changes caused by observational biases. The results obtained in this study are more thoroughly presented in Malinen et al. (2011). The present study is relevant to many Galactic studies that are being conducted with Herschel satellite and will be continued with the future high-resolution ALMA observations.

**Figure 1.** High opacity model: simulated 250 µm intensity map before adding noise.

**Figure 2.** High opacity model: closeup of the area marked with a rectangle in Figure 1 of intensity and colour temperature maps before (left frame) and after (right frame) adding the heating sources.

**Figure 3.** Moderate opacity model (without added sources): (Left) Cumulative core mass spectra. Colour temperature is calculated using 250 and 500 µm maps. (Center) Relation of true mass vs. observed mass (within 20 pixel radius) using 250/500 µm maps before adding the source (L means the luminosity of the source to be added in the clump and is related to the mass of the clump). (Right) True mass vs. observed mass using all Herschel wavelengths (100, 160, 250, 350, 500 µm).

**Figure 4.** High opacity model (250/500 µm): cumulative core mass spectra before adding the heating sources (left frame) and after it (right frame). True mass spectrum is derived from true column density map using observed clumps.

**Figure 5.** Moderate opacity model: correlation between dust temperature T and emissivity spectral index $\beta$. The colour scale indicates logarithmic density of points and the dashed line marks the average $\beta$. (Left) Without added sources. (Right) With added heating sources.

**References**