

Exercises for Radiative Transfer in Astrophysics (SS2013)

Cornelis Dullemond

Exercise sheet 5

Spherical circumstellar dusty envelope model (part I)

We will model an optically thick spherically symmetric dusty cloud around a star using the radiative transfer code RADMC-3D.

1. Download the latest version of the RADMC-3D code from the code website¹. Compile the code (using the command “make” in the `src` directory). NOTE: You don’t need to have IDL, because the exercises have all been designed to avoid IDL.
2. Download the files `problem_setup.f90` and `dustkappa_silicate.inp` from the lecture web page. Put these into a new directory (e.g. call this `run_1` or so).
3. Study the `dustkappa_silicate.inp` file: this is the opacity file. Make a log-log plot of the absorption opacity versus wavelength. You should recognize this from the lecture.
4. Now study the program `problem_setup.f90` and try to understand what it does. In particular
 - (a) How is the spatial grid defined?
 - (b) What is the density structure of the dusty envelope, and which parameters determine this structure and how?
 - (c) How are the stellar properties defined?
 - (d) What is the meaning of all the files it is writing? Please read the RADMC-3D manual (in the directory `manual/`) to figure this out.

Please explain all these things in your report.

5. Now compile `problem_setup.f90` with e.g. `gfortran problem_setup.f90`, and then execute the program with e.g. `a.out`. Verify that the files have been written. Check that the numbers in the file make sense.
6. Type `radmc3d mctherm` and see that RADMC-3D is performing the thermal Monte Carlo iteration. Once the temperature structure is written into the file `dust_temperature.dat`, make a plot of the resulting temperature as a function of radius (in a log-log fashion). You will need to use the data from the `dust_temperature.dat` as well as from the `amr_grid.inp` file.
7. Repeat the last two steps, but now for 10x smaller density and 10x larger density. Explain (see next page):

¹<http://www.ita.uni-heidelberg.de/~dullemond/software/radmc-3d/>

- (a) The differences in behavior (in particular the speed) of the code for the three cases.
- (b) The differences in the temperature profiles for the three cases.