Exercises for Radiative Transfer in Astrophysics (WS2017)

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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 website[1]. Compile the code (using the command "make" in the `src` directory). NOTE: You don't *need* to have IDL or Python, because the exercises have all been designed to avoid IDL or Python. But for plotting it might of course be useful.

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.