

Exercises for Radiative Transfer in Astrophysics (SS2013)

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Exercise sheet 8

Make your own opacities with a Mie code

1. Make an opacity table

- (a) Download the Bohren & Huffman Mie code `bhmie.f` from the website of Draine³.
- (b) Download the `Makefile` and `make_ca_cs_g.f90` codes from the lecture website.
- (c) Put them all into a directory and type “make” to compile. If all goes well, a code with the name `makeopac` has been generated.
- (d) Download an optical constants file from the Jena database⁴ or from the Refractive Index website⁵. Take what you like. Make sure that the file has three columns: first is the wavelength in *micron* (μm), the second is n and the third is k . Remove any header lines that may be present. The file *must* have `.lnk` as extension to the file name.
- (e) Create a file called `param.inp` with four lines:
 - i. First line is the name of the optical constants file *without* the `.lnk` extension.
 - ii. Second line is the grain radius in *centimeter*.
 - iii. Third line is the material density in gram/cubic-centimeter.
 - iv. Fourth line should, for now, be “1”.
- (f) Now call the `makeopac` code and make a plot of the absorption opacity that was created (the file `dustkappa_***.inp` where `***` stands for the name of the material). Repeat this for different grain sizes.

2. Make a scattering phase function

- (a) Select one line from your refractive index file (the `***.lnk` file) for a wavelength near to $\lambda = 0.55 \mu\text{m}$. Make a new `***.lnk` file that contains only this single line.
- (b) Now change the 1 in the `param.inp` file into 901. This is the number of angles.
- (c) Restart the `makeopac` code and study the `dustmatrix_***.inp` file, which contains 5 columns: θ , Z_{11} , Z_{12} , Z_{33} , Z_{34} for 1801 angles⁶.
- (d) Plot the phase function for scattering.

³<http://www.astro.princeton.edu/~draine/scattering.html>

⁴<http://www.astro.uni-jena.de/Laboratory/Database/databases.html>

⁵refractiveindex.info

⁶The normalization of the Z matrix here is per gram of dust instead of per particle.