Exercises for Radiative Transfer in Astrophysics (WS2017)

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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 Draine[2].

   (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 database[3] or from the Refractive Index website[4]. 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 $\lambda = 0.55\,\mu$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 angles[5].

   (d) Plot the phase function for scattering.

[2] `http://www.astro.princeton.edu/~draine/scattering.html`

[3] `http://www.astro.uni-jena.de/Laboratory/Database/databases.html`

[4] `refractiveindex.info`

[5] The normalization of the Z matrix here is per gram of dust instead of per particle.