Name: _____

**ATOC/ASTR 5560 Radiative Processes — Lab 6**

October 19, 2001

The purpose of this lab is to learn about the behavior of Rayleigh scattering from single particles and learn about particle size distributions. Log in to nit and copy the following files to your directory:

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|---|---|
| `/home/rt/rayleigh/rayleigh.pro` | IDL lab file |
| `/home/rt/rayleigh/shettle.dat` | aerosol index of refraction file |
| `/home/rt/rayleigh/mie_aerosol_w10.dat` | Mie scattering results |

1. Code the expressions for Rayleigh absorption and scattering cross sections in the IDL file in section `plot_rayleigh_accuracy`.

2. Plot the Rayleigh absorption and scattering cross sections and the Mie cross sections as a function of particle radius. The Mie cross sections are computed for aerosols composed of ammonium sulfate and sea salt at a wavelength of 10 $\mu$m. Look in `shettle.dat` for the index of refraction of these aerosols at this wavelength.

   At what radii do the Rayleigh absorption and scattering cross sections diverge from the Mie results by 10% (for each case)?
   (for example use `print, r[where(abs(Csca1/Csca1mie-1) gt 0.10)]`.

3. Graph the same Rayleigh-Mie comparison on a log-log plot (use `/xlog, /ylog` in the `plot` command). Explain the slopes of the lines. At what radius does the Mie scattering cross section reach the absorption cross section for each aerosol?

4. Use section `plot_distribution` to make plots of the log normal particle **number** and **volume** distributions with i) $N_{tot} = 100\ \mathrm{cm}^{-3}$, $r_0 = 0.2\ \mu$m, $\sigma = 0.40$, and
ii) $N_{tot} = 100\ \mathrm{cm}^{-3}$, $r_0 = 0.1\ \mu$m, $\sigma = 0.70$. The volume distribution is the distribution of particle volumes as a function of radius ($V(r)$ instead of $n(r)$). The IDL section makes the plots in terms of linear and log radii.

   First you will need to code the lognormal distribution formula in the IDL function, and then make the volume distributions from the number distributions in `plot_distribution`.

   What is the radii of the peaks in the number and volume distributions
   (use `print, max(dist1,i), r[i]`)?

   Why do the volume distributions peak at almost the same radius although the $r_0$'s differ by a factor of two?

5. Use the `integrate_rayleigh` section of the IDL file to numerically integrate the Rayleigh absorption cross sections to find the volume absorption coefficient $\beta_{abs}$. Use the first size distribution for the ammonium sulfate aerosols and the second size distribution for the sea salt aerosols. Convert the units to km$^{-1}$.

Please turn in all the plots along with the answers to the questions.