Exercises for Radiative Transfer in Astrophysics (SS2013)

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Exercise sheet 3

Lambda Iteration

1. **Multiple isotropic scattering in a 1-D plane-parallel atmosphere**
   Consider a semi-infinite ($-\infty < z \leq 0$) 1-D vertical plane-parallel atmosphere with a constant extinction coefficient: $\alpha = 1$ for $z \leq 0$ (and $\alpha = 0$ for $z > 0$). The albedo $\eta \equiv 1 - \epsilon$ is also constant. The value of the Planck function is taken to be $B = 1$ for convenience. Let us use the *two-stream approximation* for the Lambda operator. At the top of the atmosphere we have an open boundary: Radiation can escape freely and no radiation enters the atmosphere. Let us put the bottom boundary at $z = -10$ and put $I_+ = 1$ as the bottom boundary condition. Use 100 gridpoints in z.

   (a) Write a computer program that solves this radiative transfer problem using Lambda Iteration.

   (b) Let us choose $\epsilon = 0.5$. Start with the mean intensity $J(z) = 0$ as initial guess. Plot $J(z)$ for consecutive iterations.

   (c) Now do the same for $\epsilon = 10^{-1}$. Notice that the convergence is slower.

   (d) Now try $\epsilon = 10^{-3}$. What do you see?

For all exercises, please always do the following:

- Make an electronic document (DOC or PDF) which includes your text concerning the exercises, as well as figures belonging to it.
- Upload your document *and your computer program* to the Moodle.