Exercises for
Radiative Transfer in Astrophysics (WS2017)

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Exercise sheet 1

Radiative quantities

During this first exercise class we will spend substantial time on getting the compilers and plotting software installed on your laptops that you need for the computer exercises in the coming weeks.

In addition, please solve the following questions.

1. **Spherical geometry**
   Consider an isotropic radiation field, e.g. the radiation field you expect inside a thermal cavity. Let us count photons moving in certain directions. We use the usual polar coordinates θ and ϕ, with the z-axis as reference axis. Here $\theta = 0$ means: along the z-axis toward positive z. Define $\mu = \cos\theta$.

   (a) Prove that there are statistically as many photons moving per second per cm^2 into directions between $0 \leq \mu < 0.5$ as there are between $0.5 \leq \mu < 1$.

   (b) Generalize this to any interval $\mu_1 \leq \mu < \mu_1 + \Delta\mu$ with given constant $\Delta\mu$.

2. **The $1/d^2$ law of the flux**
   Consider a perfectly spherical star with a perfect blackbody spectrum.

   (a) Prove, using the law of energy conservation, that the observed flux from the star must go inversely proportional to the distance-squared d^2 of the observer to the center of the star, also in the near-field limit.

   (b) Prove that this is consistent, also in the near-field limit, with the constancy of intensity.

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 possible figures belonging to it.
- Upload your document *and your computer program (if applicable)* to the Moodle.