Homework 07

Problem 1 (5 points)

Read extra carefully part 9.2 of the book, pay attention to the definition of the Rossseland mean opacity. What are the mechanisms due to which opacity grows steeply with increase of temperature and then drops (refer to figure 9.10)?

Problem 2 (5 points)

Solve problem 9.1 from the text book. Use the equation 9.7 to estimate energy density in the closed volume. Then estimate energy delivered from the bulb through a pupil of an eye.

Bonus Problem 3 (5 points)

Solve problem 9.6 from the text book.

Problem 4 (5 points)

If we compare Hydrogen and Nitrogen atoms spectra of the Solar radiation. What is the ratio of their Doppler broaden linewidths? Assume that relevant temperature of the Sun is 5800 K.

Problem 5 (5 points)

If a particular spectral line is only naturally broadened (i.e. no pressure or Doppler broadening) then its shape is given by Lorentz profile. In this case the optical depth is given by

$$\tau(\rho, \Delta\lambda) = \frac{\rho}{\rho_0} \frac{1}{1 + (\Delta\lambda/\gamma)^2} \tag{1}$$

where $\Delta\lambda = \lambda - \lambda_0$ detuning from the center of the absorption line and γ is the natural linewidth of this line.

Plot transmission Voigt profiles

$$T = e^{-\tau(\rho,\Delta\lambda)} \tag{2}$$

as a function of a relative detuning $x = \Delta\lambda/\gamma$ for different density ratios (ρ/ρ_0).

Make sure that you catch a behavior of the growing absorption with increase of density and then broadening of the absorption line once it hits the zero of transmission. Essentially you should recreate figure 9.20. Though it might look different for large ρ, since we disregard the pressure broadening.

Note: feel free to use some software. But I will not accept hand drawn plots and *especially* the ones made with MS Office Excel or OpenOffice or LibreOffice (essentially anything which is made with Office like products).

Bonus problem 6 (5 points)

Based on problem 5 try to recreate the curve of growth depicted at figure 9.21. Numerical, integration techniques will be super handy for this problem.