Sample Problems-Interstellar Medium

1. The luminosity of the central star L_v is given by A/v^{-1}. The photoionization cross section a_v is given by $a_v = a_0/v^{-1}$ for $v \geq v_0$. What is the rate of photoionization in $\text{cm}^3 \text{ s}^{-1}$ in a gas of density $n \text{ cm}^{-3}$? Ignore optical depth effects.

2. The rate of recombination in an ionized gas is $\alpha(T)n_e^2 \text{ cm}^{-3} \text{ s}^{-1}$ where n_e is the electron density. If the ionization source is switched off at time t_0 when the electron density is $n_e(t=0)$, how does n_e vary with time?

3. A star lies at a distance of 500 pc and has a visual extinction of five magnitudes due to dust grains, assumed to be spherical with a radius of 500 nm. If the dust absorbs radiation with unit efficiency, what is the mean density of dust grains along the line of sight to the star?