Physics of the Interstellar Medium

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Exercises IV

In–Class Exercises

1 Line Radiation of Neutral Hydrogen

1.1 Emission and absorption

- Suppose to consider a uniform, extended HI cloud with a physical temperature of T_C=2.73 K. If the only background source is the 2.73 K microwave background, how would you expect to observe the HI line?

- Repeat if there is a background source with main beam brightness temperature T_{MB}=3 K. What would be the temperature of the absorption ΔT_L (in K), if τ=1?

- Repeat for T_C=3.5 K.

1.2 Radiation Transfer

Assume that we measure the number of photons originating ON (I_{ON}=50 cts) and OFF (I_{OFF}=320 cts) a cloud of interest. We know the photoelectric absorption cross section (σ=1.25$\times$ 10^{-20} cm^2) and the column densities of the cloud N_H(ON)=8$\times10^{20}$ cm^{-2} and OFF the cloud N_H(OFF)=8$\times10^{17}$ cm^{-2}

- Find the appropriate radiative transfer equation.

- What fraction of the I_{ON} is produced by the background source.

- Calculate the number of counts originating from the foreground and background in the OFF position.

- Calculate the mean free-path length of a photon in units of pc assuming a hydrogen volume density of 100 cm^{-3} and the above photoelectric absorption cross section.