Problem 1 :
The surface density of our Galaxy’s disk is $\sim 50 \, M_\odot/pc^2$ and its thickness is $\sim 500 \, pc$. Given that its mass is $\sim 1/45$ of the total mass of our Galaxy ($M_{\text{tot}} = 2 \times 10^{12} M_\odot$), estimate its radius and its mean density. Given that the Sun is at $R_{\text{sun}} = 8 kpc$ from the Galaxy center and that its rotation period is 220 Myr, estimate the mass inside a sphere of $R_{\text{sun}}$.

Problem 2 :
Estimate $N_\nu$, the number of neutrinos required so that their mass is of the same order to the mass of the dark matter halo of a typical galaxy. Consider a mass energy of $1 \, eV$ as a superior limit to the neutrino mass.

Problem 3 :
For a galaxy cluster and for a galaxy, estimate the ratio between the volume of the $N$ components and the total volume of the system. Consider a mean radius of $R_\ast = 10^6$ km for the stars.

Problem 4 :
For a galaxy cluster and for a galaxy, estimate the ratio between the volume of the tube travelled by one of the component during $t = 10^{10}$ years and the total volume of the system. Consider a mean radius of $R_\ast = 10^6$ km for the stars.

Problem 5 :
Estimate the gravitational influence radius $R_G$ for a galaxy moving within a galaxy cluster and for a star moving within a galaxy.