Astrophysics III : Stellar and galactic dynamics

Exercises

Problem 1 :

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

Problem 2 :

Estimate N_ν, 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 $R_\star = 10^6$ 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 $R_\star = 10^6$ 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.