ASTR368
HW#3
February 2, 2024
Due February 8, 2024
2 points each part unless otherwise stated

1) Researchers are always revising the values of R_0 and Θ_0 as more data are collected. The current best values are $R_0 = 8.2$ kpc and $\Theta_0 = 235\ \mathrm{km\,s^{-1}}$ but the "official" values are $R_0 = 8.5$ kpc and $\Theta_0 = 220\ \mathrm{km\,s^{-1}}$.
a) (4 pt) What is the difference, as a percentage, of the mass interior to the Sun comparing the new values official values? Hint: Balance circular acceleration with gravitational acceleration for a test mass, then solve for mass interior. We will use this derivation over and over - make sure you understand it!
b) Again assuming the current best values for the Galactic rotation parameters, what is the difference as a percentage in the computed distance to a source for a given radial velocity? Hint: Compute Oort A for both cases.

2) Assume you are measuring the radial velocity of H I gas along the a line of sight $\ell = 45\,^\circ$, $b = 0\,^\circ$. State all relevant assumptions.
a) Use the Law of Cosines to solve for R as a function of d. A picture will help.
b) Compute R for values of d in 0.5 kpc increments for distances from 0 to 15 kpc. Place these in a table (Excel/code suggested; by hand would be slow).
c) Compute the radial velocity and add it to the table.
d) Plot the radial velocity as a function of distance for $\ell = 45\,^\circ$. Be sure to use correct units. Label the tangent point distance. What does the distance at which $v_r = 0\ \mathrm{km\,s^{-1}}$ correspond to?

3) (8 pt) For a simple model of the Galaxy with $\Theta(R) = 235\ \mathrm{km\,s^{-1}}$ everywhere and $R_0 = 8.2$ kpc, find $v_r(\ell)$ for gas in a circular orbit at $R = 4, 6, 10, 12$ kpc. Make a plot similar to the one below showing where gas on these rings is located. Hint1: think about how Ω varies at these Galactocentric radii. Hint2: do not use Oort's formulae. Not all longitudes are valid for a given R.
Prove to me that this is your own work, by attaching the source code in hardcopy or sending me the file electronically. Use any program you like (Excel works fine).

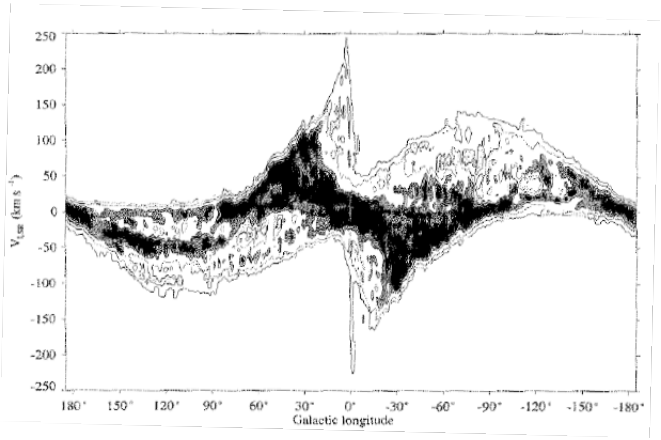

Figure 1: H I longitude-velocity diagram