Introduction to Astronomy
Exercises week 12

10 January 2020

1. Assuming stars are uniformly distributed in space and there is no interstellar extinction, show that the number of stars brighter than apparent magnitude m, is:

$$N(m) = N_0 \times 10^{0.6m},$$

with N_0 a proportionality constant. (Hint: start off by assuming all stars have identical absolute magnitude M, then calculate the distance for stars of apparent magnitude m. Go from there.)

2. The "3-kpc arm" is a feature in our Galaxy that appears to be expanding away from the Galactic Centre with $V_{\rm exp} = 50\,{\rm km/s}$. Assume that this feature is a donut-shaped ring with a radius of 3 kpc and a total mass of $6 \times 10^7\,{\rm M}_\odot$. Find the kinetic energy of this feature. If this energy is supplied by supernovae (SNe), each with an available energy of $10^{44}\,{\rm J}$, how many SNe would be needed to supply the kinetic energy?

3. We observe an HI cloud at Galactic longitude $l = 111°$. The cloud has a radial velocity of $v_{\rm R} = -40\,{\rm km/s}$. Calculate the distance to the cloud, assuming a constant Galactic rotation velocity of 240 km/s and taking $R_0 = 8\,{\rm kpc}$ for the distance between the Solar System and the Galactic Centre.

4. For stars on the Solar circle (i.e. with a distance to the Galactic Centre of 8 kpc, like our Sun), the proper motion caused by Galactic rotation is independent from the stellar distance. Prove this by determining the value of this proper motion, assuming the constants given in the previous question.