Problem Paper II:2

Question 1

Suppose that the Sun's distance from the centre of the Galaxy is 8.0 kpc, and its orbital velocity about the centre is 220 km/s. Calculate the length of the Galactic 'year' (the time taken for the Sun to complete one orbit around the Galaxy), expressing your answer in (Earth) years.

Calculate how many times the Sun has orbited the Galaxy. (Assume that the age of the Sun is 0.5×10^{10} yr.)

Calculate the total mass contained within the solar orbit, expressing your answer in solar masses.

Question 2

The redshift, z, of distant galaxies can be measured from the doppler displacement of features in their spectra. The redshift can be directly converted to a velocity of recession (using the relativistic doppler formula), and thence to a distance (since there exists a proportionality between distance and velocity; we will discuss this in lectures shortly). Finally, because light has a finite velocity, and so takes a finite time to reach us from distant galaxies, the redshift tells us the age of universe (that is, the time elapsed since the Big Bang) at the time when the galaxy emitted the light we now see.

Using Ned Wright's 'cosmology calculator',[1]
`http://www.astro.ucla.edu/~wright/CosmoCalc.html`,
tabulate the distances[2] of galaxies at redshifts of 0.1, 0.5, 1.0, 2.0, 4.0, 6.0, 10.0 and 100.0, together with their ages (the time since the Big Bang).

[In fact, there are certainly no galaxies at $z = 100$, and it's unclear if there are any at $z = 10$, but let's not worry about that little detail...
Diligent students might consider computing results for some intermediate redshifts, and presenting the results graphically, but this isn't required. If you *do* do this, you might find it easier to take logs of all quantities before plotting.]

[1] Accept the default parameters of $H_0 = 71, \Omega_{\rm M} = 0.27, \Omega_{\rm vac} = 0.73$, and adopt a 'General' calculation.

[2] The calculator returns several different 'distances'; you can follow the links from the web page if you're interested in the details, but here we want the 'comoving radial distance'.