Astro 425 Cosmology: Problem Set 4

Due Nov 14th 2016 (1 and 2)
Nov 21st 2016 (3)

1. [10 pts] Consider two distant galaxies both along the same line of sight. The closest galaxy is at a redshift z_1 and the more distant galaxy at a redshift z_2. By considering how a photon might travel from galaxy 2 to galaxy 1 and then to an observer at redshift 0 calculate.
    a. The redshift of second galaxy if observed from the first galaxy (in terms of z_1 and z_2)
    b. For a flat universe with Ω_m=1 (Einstein-deSitter) calculate the angular diameter distance to galaxy 1 and 2 (if z_1=0.5 and z_2 = 1.6) and the angular diameter distance from galaxy 1 to galaxy 2
    c. Comment on the similarity or difference between these values.

2. [10 pts] Problem 8.5 in Ryden: Note there is a typo in the problem (it states that the velocity dispersion units are km s^{-3} rather than the correct units of km s^{-1}). Compare this with the collision time between Andromeda (M31) and the Milky Way (Andromeda is 700 kpc away and is moving towards us at 120 km s^{-1}).

3. [20 pts] Assume a gravitational lens that is a point source. Using the lens equation

$$\beta = \theta - \frac{D_{LS}}{D_S D_L}\frac{4GM}{c^2\theta}$$

write a program to lens a background source by a foreground mass. Have the program produce a set of two figures: one with the position of the background source relative the lens and a second figure with the resulting lensed image. Generate these images for two configurations: (a) where the background source is almost directly behind the lens and (b) when the background source is just inside the Einstein radius of the lens.

For added credit use an image of distant galaxies from Hubble and apply your lens to this astronomical scene.

Hint: think about what values you should choose for the mass of the lens and the distance to the lens and source, and also about how you should trace the path of the photon (from the source to the observer or the observer to the

source).