

Cosmology homework

Assume for the questions below a flat ($k = 0$) Universe with cosmological parameters ($\Omega_m = 0.3, \Omega_\Lambda = 0.7, h = 0.72$), and use a radiation density $\Omega_r = 4.22 \times 10^{-5} h^{-2}$ in case you cannot neglect the radiation. If possible, express your answers in a way that is independent of the actual value of the Hubble parameter h .

1. Give the expression for, compute, and plot

- (a) the co-moving distance r
- (b) the angular size-diameter distance d_A
- (c) the luminosity distance d_L
- (d) the age of the Universe t

for redshifts $z = [0, 10]$. Does d_A reach a maximum? If so, what is its value, and at which redshift does it occur? [10 marks]

2. A galaxy undergoes a strong star burst at redshift $z = 4$. Compute the age of its stars at $z = 3$. [4 marks]
3. A redshift survey uses the Lyman- α emission line ($\lambda = 1215.67\text{\AA}$) to detect high-redshift galaxies. The filter is centred on wavelength $\lambda = 4862.24\text{\AA}$ and has width $\Delta\lambda = 30\text{\AA}$. You may assume the filter is a perfect top-hat. The image size of the telescope used is 5 arc min on a side. Calculate
 - (i) the co-moving volume surveyed.
 - (ii) the physical volume surveyed.

These observations detect a particularly interesting galaxy, which is followed-up by more observations. Its observed surface brightness is $\mu = 28$ magnitude per square arc seconds. Calculate its intrinsic surface brightness. [6 marks]