DMDE Exercise 4

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1 Problem 1: Baryon Acoustic Oscillations

1.1 Part a: Plot the angle subtended by BAO in degrees as a function of redshift.

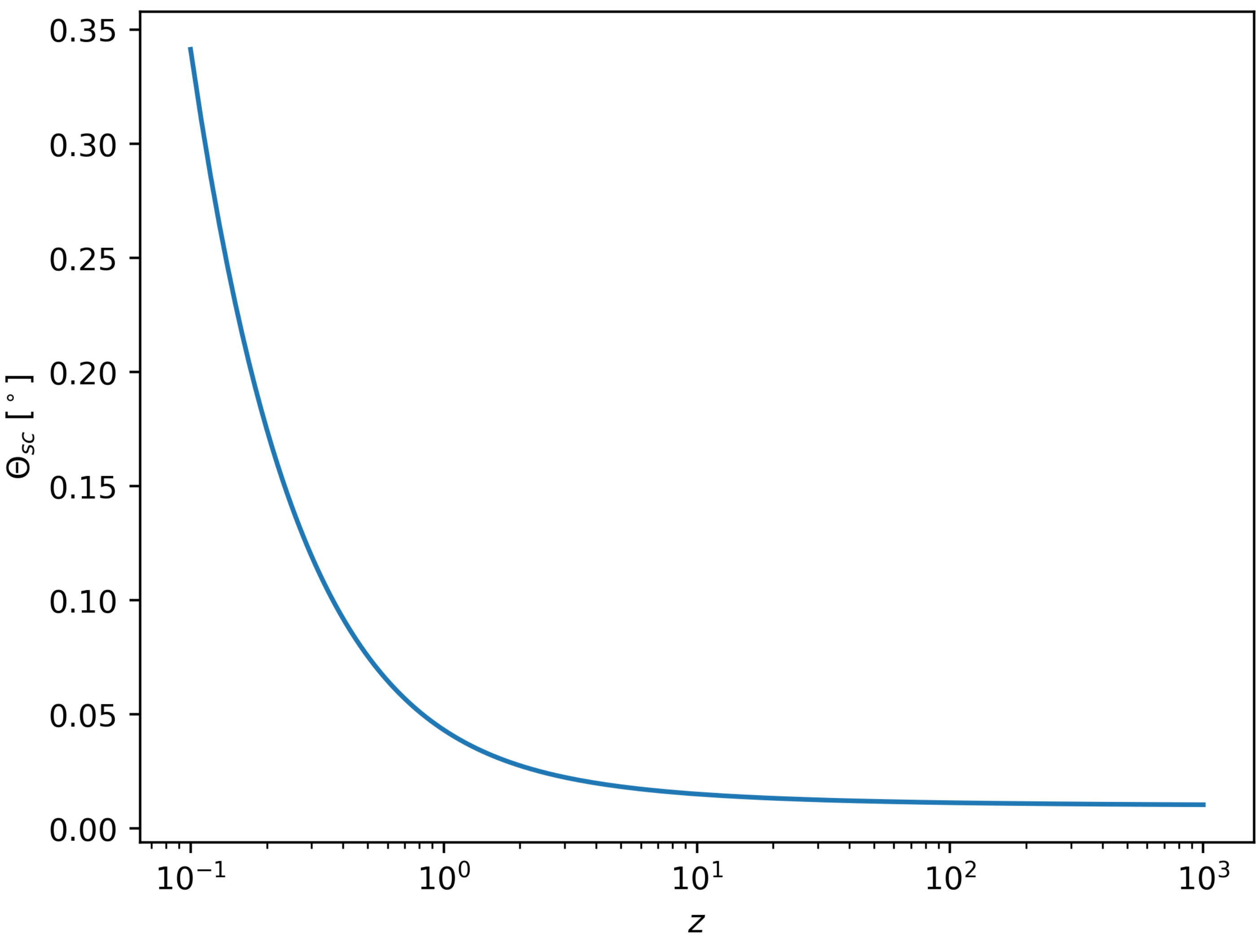

Figure 1: The angle subtended by BAO in degrees, Θ_{sc}, as a function of redshift z. At low z, the angle is large, and drops rapidly with increasing redshift, approaching a constant value. Using: l_{BAO}=100 Mpc/h, h=0.67, w_{DE}=-1, Ω_m=0.3, Ω_{DE}=0.7.

1.2 Part b: How can this be used to constrain the cosmological parameters?

Baryon Acoustic oscillations provide a standard ruler with fixed comoving length for the clustering of matter in the Universe which can be computed using straightforward physics. The angle subtended by the sound horizon is related to the angular diameter distance as a function of redshift, which can then be used to constrain the Hubble parameter as a function of redshift which provides good constraints on the nature of the expansion of the Universe and Dark Energy. The following expressions show the mathematical relationship.

$$\theta = \frac{l_{BAO}}{(1+z)D_A(z)} \tag{1}$$

$$D_A(z) \propto \int_0^z \frac{dz'}{H(z')} \tag{2}$$

2 Problem 2: Cluster Luminosity

2.1 Part a: Plot the X-ray luminosity L_x vs z.

Figure 2: X-ray luminosity (L_x) vs redshift z for clusters.txt. Using: l_{BAO}=100 Mpc/h, h=0.67, w_{DE}=-1, Ω_m=0.3, Ω_{DE}=0.7.

2.2 Part b: On the plot in (a), add the flux limit line.

Equation 3 is used to calculate the luminosity limit line in the rest frame of the clusters. d_L is the luminosity distance as a function of redshift.

$$L_x = (5 \times 10^{-12})(1+z)(4\pi d_L^2) \tag{3}$$

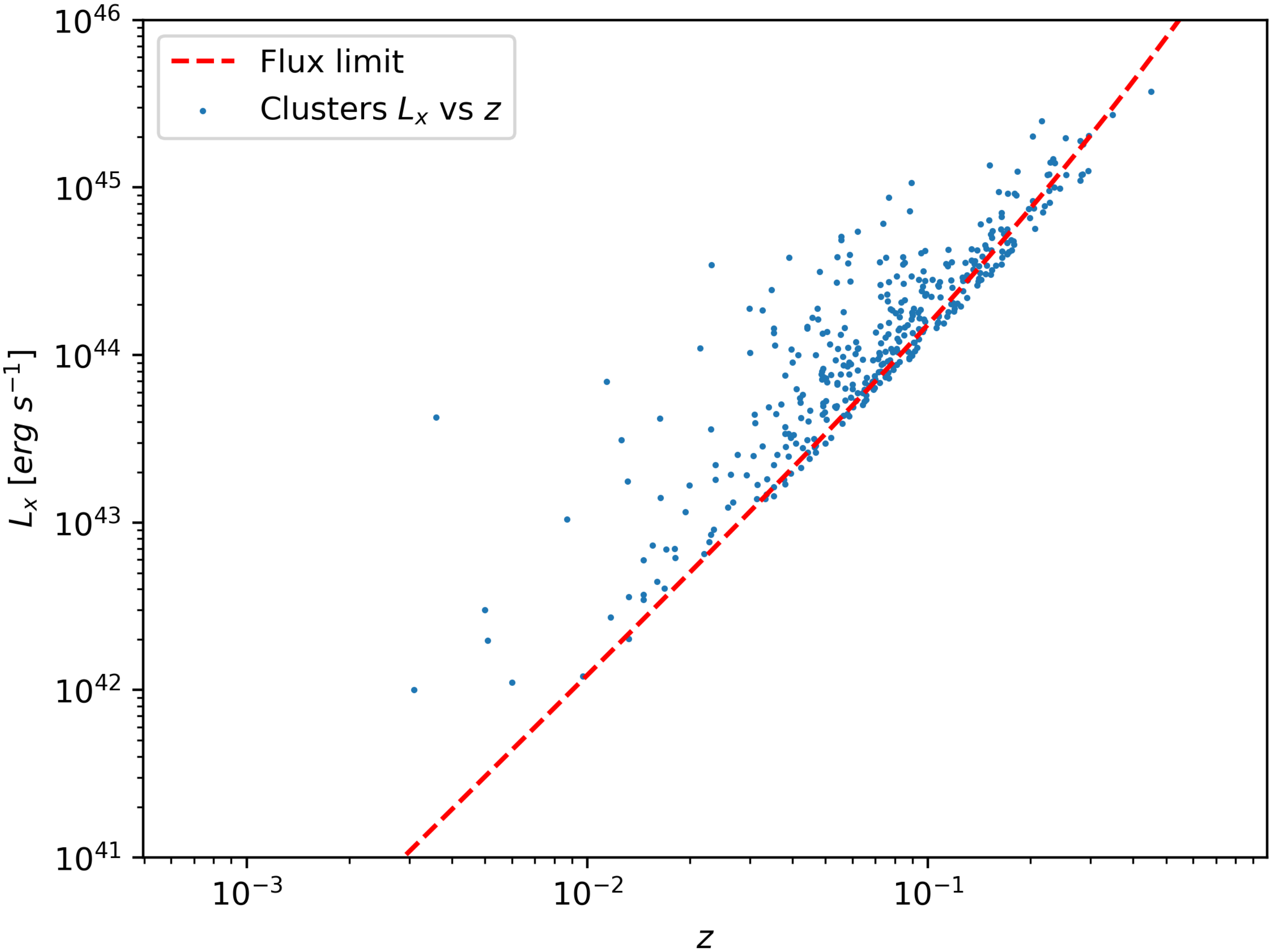

Figure 3: X-ray luminosity L_x vs redshift z for clusters.txt. The red dashed line represents the theoretical flux limit f_X(0.1-2.4keV) $\geq 5 \times 10^{-12}$ $erg\ s^{-1}\ cm^{-2}$. Using: l_{BAO}=100 Mpc/h, h=0.67, w_{DE}=-1, Ω_m=0.3, Ω_{DE}=0.7. Some of the clusters appear below this flux limit line. The flux limit was calculated using equation 3.

2.3 Part c: Do all the clusters appear above the flux limit line? Why is this the case?

Not all clusters appear above the flux limit line. This occurs because there is not a one-to-one correspondence of flux and photon count rate at the detector due to dependence of the count rate on the nature of the observed spectrum of the emission such as the gas temperature and spectral index.

3 Code

The python script used to produce the results in this report is available at `https://github.com/tomcarron/DMDE_Ex4.git`