Assigned: Friday, December 17, 2021 **DMDE Exercise 4**
Due: 13:00, Wednesday, January 12, 2022 16 points

Note that submitted solutions should be in PDF format and include the code that produced your plots! Submissions without code will not be graded! Python users may find the `astropy.cosmology` package useful for these exercises. Send any questions to hannah.mccall@uni-bonn.de!

Problem 1: Baryon Acoustic Oscillations (8 points)

Use 100 Mpc/h as the BAO length scale, $h = 0.67$, $w_{DE} = -1$, $\Omega_m = 0.3$, and $\Omega_{DE} = 0.7$ for the following problem.

a) Plot the angle subtended by BAO in degrees as a function of redshift. (5 points)

b) How can this be used to constrain the cosmological parameters? You may use a different set of parameters to justify your answer. (3 points)

Problem 2: Cluster Luminosity (8 points)

For this problem, use data from `clusters.txt`, which you can find on eCampus. The sample of clusters in this file is flux limited such that $f_X(0.1 - 2.4 \text{ keV}) \geq 5 \times 10^{-12}$ erg s^{-1} cm^{-2}. The given f_X limit in the 0.1-2.4 keV energy band corresponds to our (the observer's) rest frame, while the L_X values correspond to the 0.1-2.4 keV energy band in the cluster's rest frame.

a) Using the same cosmology parameters as the previous question, plot the X-ray luminosity L_X vs z. (3 points)

b) On the plot above, add the flux limit line (the lowest L_X that can be observed for every z based on the given flux limit). Make sure to show the equation you use to plot this limit line. (3 points)

c) Do all the clusters appear above the flux limit line? Why is this the case? (2 points)