Prof. Dr. Alexandre Réfrégier
Alexander Reeves, Dr. Devin Crichton Fall 2023

Cosmological Probes

Problem Set 4

Hints: 19.10.2023
Due/Solutions: 26.10.2023

Note:

The numerical part of this exercise can be solved on the JupyterHub which you can access through Moodle. Please ensure you have opened the JupyterHub once through moodle before trying to access the assignments. For most problems, we use the cosmology code PyCosmo. To learn more about PyCosmo, you can have a look at the online documentation at `https://cosmo-docs.phys.ethz.ch/PyCosmo/` and read the corresponding paper at `https://arxiv.org/abs/2005.00543`.

1 Wavenumber at equality

Compute the wavenumber of the mode which equals the inverse comoving Hubble radius at equality. That is, define $k_{\rm eq}$ to be equal to $a_{\rm eq}H(a_{\rm eq})$. Show that this implies

$$k_{\rm eq} = \sqrt{\frac{2\Omega_m H_0^2}{a_{\rm eq}}}. \tag{1}$$

Then, using $a_{\rm eq} = 4.15 \times 10^{-5}\Omega_m^{-1}h^{-2}$, show that $k_{\rm eq} = 0.073{\rm Mpc}^{-1}\Omega_m h^2$.

2 Growth factor

Plot the growth factor as a function of a for the following cases of flat cosmologies using PyCosmo:

1. $\Omega_m = 0.25$ and $\Omega_b = 0.05$
2. $\Omega_m = 0.30$ and $\Omega_b = 0.05$
3. $\Omega_m = 0.35$ and $\Omega_b = 0.05$
4. $\Omega_m = 0.25$ and $\Omega_b = 0.10$
5. $\Omega_m = 0.30$ and $\Omega_b = 0.10$
6. $\Omega_m = 0.35$ and $\Omega_b = 0.10$.