Observational Cosmology Year 3 Assessed Problems # 2

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due on November 20, 2019 at 3:30 pm (ESO)

Consider the Universe at the epoch of decoupling of photons from matter, which happened when the temperature was T ~ 3000 K. Assume that the Universe has $\Omega_{M,0} = 0.31$, $\Omega_{\Lambda,0} = 0.69$ and $H_0 = 68 \frac{\text{km s}^{-1}}{\text{Mpc}}$.

- 1. Derive the redshift corresponding to the epoch of decoupling. [1]
- 2. By making appropriate approximations, derive the value of the Hubble parameter at that epoch. [3]
- 3. Derive an order-of-magnitude value for the mean free path of photons at the epoch of decoupling. [3]
- 4. How does it compare with the mean free path of the CMB photons today? [1]
- 5. Derive an estimate for the Jeans mass just after decoupling, stating your assumptions clearly. [2]

Guidelines

• This sheet accounts for 10% of the credit of the course. Marks are in bold within brackets.