

Galaxies and Cosmology

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Problem 1 – Closed Universe (3pt)

Imagine flying through a closed Universe with $h = 0.7$, $\Omega_m = 0.7$, $\Omega_r = 0$, and $\Omega_\Lambda = 0.7$ without changing course. After what distance are you back at your starting point? Give your answer in Mpc.

Problem 2 – Causal connection (3pt)

Recombination took place in the Universe at $z_{\text{rec}} \approx 1000$. Let's define 'causality': two causally connected points must have a third point in the past, from which signals could have been sent to the two points. What is the maximum comoving distance D_{caus} of two causally connected points at the time of recombination? Assume $\Omega_m = 1$ and $\Omega_r = \Omega_\Lambda = 0$.

Problem 3 – Opening angle (4pt)

Consider problem 2: Which opening angle subtends today the distance $D_{\text{caus}}(z_{\text{rec}})$? Determine also the opening angle for the concordance model $\Omega_m = 0.3$, $\Omega_r = 0$, and $\Omega_\Lambda = 0.7$. (Evaluate the integral numerically.)