PHYS 480/581
Cosmology

Worksheet #10
Monday 09/26/2022

Question 1.

Even without knowing the absolute luminosity of certain astronomical objects, it is possible to extract important cosmological information from the *difference* in apparent magnitude between two similar objects. Consider two Type Ia supernovae, one at $z_1 = 0.1806$ and apparent magnitude $m_1 = 20.3864 \pm 0.1142$, and the other at $z_2 = 0.69315$ with apparent magnitude $m_2 = 23.7964 \pm 0.2444$.

(a) Derive an expression for the ratio $d_{\mathrm{L}}(z_2)/d_{\mathrm{L}}(z_1)$ as a function of $m_2 - m_1$. Argue that this ratio is independent of H_0.

(b) Use the expression derived in part (a) to show that a cosmological model with $\Omega_{\mathrm{m}} = 0.3$ and $\Omega_{\Lambda} = 0.7$ is a much better fit to the data than a flat matter-dominated universe with $\Omega_{\mathrm{m}} = 1$. This argument was instrumental to the discovery of dark energy.