Cosmology 1

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Proposed problem, lecture 7
Topic: luminosity distance.

Use your favourite plotting program to plot the luminosity distance d_L, as expressed by a second-order expansion in the redshift z,

$$d_L = \frac{c}{H_0}\left[z + \frac{1}{2}(1-q_0)z^2 + \mathcal{O}(z^3)\right]$$

in Mpc (1 pc $= 3.09\cdot 10^{16}$ m), for H_0 from 65 to 73 km s^{-1} Mpc^{-1}, and $q_0 = 0.5$, 0.15, 0 and -0.3.

Astronomers use apparent magnitudes to measure fluxes or, better, to measure fluxes relative to a reference star (typically Vega):

$$m - m_V = -2.5\log_{10}\frac{f}{f_V}$$

where f is the measured energy flux per unit time and unit area. Stellar luminosities are quantified through absolute magnitudes, i.e. the magnitude the star would have if it were placed at 10 pc from us. The relation of the two is

$$M = m - \mu, \quad \mu \equiv 5\log_{10}\frac{d_L}{1\ \mathrm{Mpc}} + 25$$

where μ is the distance modulus. Plot the luminosity distance as above, in terms of distance modulus. If M is known for a standard candle, the observed magnitude m will be promply translated into a distance modulus μ.