ASTR 5770 Cosmology Fall 2025. Problem Set 3. Due Wed Sep 17

1. Hubble diagram (20 points)

Exercise 10.9. I found it most convenient to do the integral numerically in mathematica.

You might like to include on your plot points and error bars from the latest data on 1048 Type Ia supernova redshifts and magnitudes reported by Scolnic et al. 2018, arXiv:1710.00845, available at https://archive.stsci.edu/prepds/ps1cosmo#dataaccess. The relevant summary data file is https://jila.colorado.edu/~ajsh/courses/astr5770_25/scolnic/hlsp_ps1cosmo_panstarrs_gpc1_all_model_v1_lcparam-full.txt.

The summary data file gives redshift z in the CMB frame, and an apparent blue magnitude m_B that has been corrected for a variety of effects, as described by Scolnic et al. following their equation (3). The classic (dating to Hipparchus) astronomer's measure of distance is the distance modulus μ, defined to equal the difference between the apparent magnitude m and absolute magnitude M of an object. The relation between distance modulus μ and distance d is

$$\mu \equiv m - M = 5 \log_{10}(d/10\,\mathrm{pc}) \ . \tag{1.1}$$

The local Hubble relation between distance d and redshift z is

$$cz = H_0 d \ . \tag{1.2}$$

To scale your plot correctly, you'll need to figure out a canonical absolute magnitude M for a standardized Type Ia supernova.