Astrophysik II: Galaxien und Kosmologie

WS17/18

Übungsblatt 12

31.01.2017

Aufgabe 1. *Parameter estimation*

The datafile, *sn_riess.dat*, contains a series of observed SN-Ia. The first column is the observed redshift, the second the observed magnitude, and the third is the observational error. Recall that the *apparent* magnitude, m, is a function of *absolute* magnitude, M, and the distance to the source D.

$$m = M + 5\log_{10}(H_0 D_L) \tag{1}$$

D_L is the luminosity distance, defined by

$$D_L = D_{com}(1+z) \tag{2}$$

The comoving distance D_{com} by

$$D_{com} = c\int_0^z \frac{dz}{H(z)} \tag{3}$$

and $H(z)$ is the Hubble parameter, defined in the usual way

$$H^2(a) = H_0^2\left(\frac{1-\Omega_0}{a^2} + \frac{\Omega_M}{a^3} + \frac{\Omega_R}{a^4} + \Omega_\Lambda\right) \tag{4}$$

Assuming a uniform prior, the joint probability of the parameters with respect to the data, is given by

$$P(M, \Omega_m|data) = \exp\left(-\frac{\chi^2 - \chi^2_{min}}{2}\right) \tag{5}$$

where

$$\chi^2 = \sum_{i=0}^{N} \frac{(m(M, \Omega_m, z_i) - m_i)^2}{\sigma_i^2} \tag{6}$$

m_i are the observed magnitudes, and σ_i is the associated error and $m(M, \Omega_m, z_i)$ are the *theoretical* values for magnitude for the observed redshift, z_i. Use the numerical integrator you build for HW 9 to explore the parameter space (for $M = [15, 17]$ and $\Omega_m = [0, 1]$). You may further assume a flat cosmology with a negligibly small radiation density.

(a) What is the minimum χ^2? what parameters are associated with this value

(b) Plot the joint likelihood contours within the parameter range you explored

(c) Plot the curve for the best fit parameters along with the observed data.

(d) Marginalize over joint the likelihood, to obtain $P(M|data)$ and $P(\Omega_m|data)$.Plot these curves. Assuming the marginalized likelihoods are Gaussian, what are the best estimate parameters.
hint: $P(M|data) = \int P(M, \Omega_m|data)d\Omega_m$