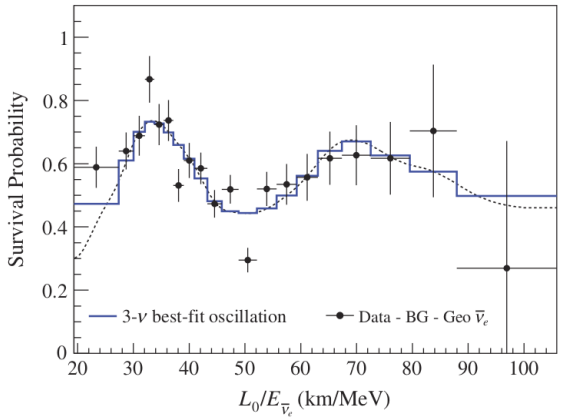
Problem set 5

Problem 1

The KamLAND experiment measured the disappearance of $\bar{\nu}_e$ anti-neutrinos produced in reactors located at ~ 180 km from the detector. Estimate the parameter Δm^2_{12} from the plot of the survival probability as a function of L/E. Compare your result with the value determined by the KamLAND experiment: $\Delta m^2_{12} = (7.53 \pm 0.18) \times 10^{-5}\,\mathrm{eV}^2$.



Problem 2

Show that the mass–squared eigenvalues for the hamiltonian describing neutrino oscillations in matter, expressed in the (ν_e, ν_μ) basis, are

$$m^2 = \frac{1}{2}(\mu^2 + B) \pm \frac{1}{2}\sqrt{(\Delta m^2 \cos 2\theta - B)^2 + (\Delta m^2 \sin 2\theta)^2}\,,$$

where $\Delta m^2 = m_2^2 - m_1^2$, and that the corresponding mixing angle is given by

$$\tan 2\theta_{\mathrm{matter}} = \frac{\sin 2\theta}{\cos 2\theta - \frac{B}{\Delta m^2}}\,,$$

where $B = 2EV_W$ accounts for the charged-current interaction potential.