Homework X: Beyond the Standard Model

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Short homework today after our lab visit. We finished up our discussion on the standard model and its extensions today, so the reading is largely about final theories.

Problem 1 Reading

Read chapters 10 and 11 of Oerter. Also read Chapters 9 (only to page 213) and 10 of Weinberg. Check out KATRIN via the links I posted.

Problem 2 Neutrino oscillations

Suppose electron neutrinos produced by a nuclear reactor travel 1.1 km before reaching a detector (this is the distance to the Double Chooz far detector). What fraction of the neutrinos reaching the detector are measured as other flavors?

You will need the neutrino mixing matrix elements from the particle data booklet, also online at http://pdg.lbl.gov/2011/tables/rpp2011-sum-leptons.pdf. The neutrino mixing matrix is parameterized as,

$$U = \begin{pmatrix} c_{12}c_{13} & s_{12}c_{13} & s_{13}e^{-i\delta} \\ -s_{12}c_{23} - c_{12}s_{23}s_{13}e^{i\delta} & c_{12}c_{23} - s_{12}s_{23}s_{13}e^{i\delta} & s_{23}c_{13} \\ s_{12}s_{23} - c_{12}c_{23}s_{13}e^{i\delta} & -c_{12}s_{23} - s_{12}c_{23}s_{13}e^{i\delta} & c_{23}c_{13} \end{pmatrix} \tag{1}$$

where

$$\begin{pmatrix} \nu_e \\ \nu_\mu \\ \nu_\tau \end{pmatrix} = U \begin{pmatrix} \nu_1 \\ \nu_2 \\ \nu_3 \end{pmatrix} \tag{2}$$