

Homework problem on Neutrino Physics (Lecture by Prof. Sin Kyu Kang on Jan.22)

The mixing among three neutrino flavor states is described by a  $3 \times 3$  unitary matrix. Show that the  $3 \times 3$  unitary mixing matrix is expressed in terms of 3 angles and 1 complex phase if neutrinos are Dirac particles, whereas it contains 2 more phases if they are Majorana particles. (Hint: To show it, you should consider Lagrangian terms for neutrino Dirac and Majorana masses, respectively, and remove unphysical phases which can be absorbed into neutrino fields by field redefinition.)