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Resolving CP Violation by Standard and Nonstandard Interactions in Neutrino Oscillations

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In neutrino oscillation with non-standard interactions (NSI) the system is enriched with CP violation caused by phases due to NSI in addition to the standard lepton Kobayashi-Maskawa phase ¥$delta$. In this paper we show that it is possible to disentangle the two CP violating effects by measurement of muon neutrino appearance by a near-far two detector setting in neutrino factory experiments.
Prior to the quantitative analysis we investigate in detail the various features of the neutrino oscillations with NSI, but under the assumption that only one of the NSI elements, ¥$varepsilon_{e¥mu}$ or ¥$varepsilon_{e¥tau}$, is present.
They include synergy between the near and the far detectors, the characteristic differences between the ¥$varepsilon_{e¥mu}$ and ¥$varepsilon_{e¥tau}$ systems, and in particular, the parameter degeneracy.
Finally, we use a concrete setting of muon energy 50 GeV and two magnetized iron detectors at the two baselines, one at $L = 3000$ km and the other at $L = 7000$ km, each having a fiducial mass of 50 kton to study the discovery potential of NSI and its CP violation effects.
We demonstrate by assuming $4¥times10^{21}$ useful muon decay for both polarities that one can identify non-standard CP violation down to ¥$vert¥varepsilon_{e¥mu}¥vert¥simeq¥textafew¥times10^{-3}$, % ¥$vert¥varepsilon_{e¥mu}¥vert¥simeq¥textseveral¥times10^{-4}$, and ¥$vert¥varepsilon_{e¥tau}¥vert¥simeq10^{-2}$ at 3¥$sigma$ CL for ¥$theta_{13}$ down to ¥$sin^2 2¥theta_{13} = 10^{-4}$ in most of the region of ¥$delta$. The impact of existence of NSI on measurement of ¥$delta$ and the mass hierarchy is also worked out.

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