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Decoherence and Neutrino Oscillations: from Microscopic to Macroscopic

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We present a generic structure (the layer structure) for decoherence effects in neutrino oscillations by combining the concept of the open quantum system and quantum field theory, which includes and parameterize decoherence effects from quantum mechanical and classical uncertainties. With the help of the layer structure, we classify the former as state decoherence (SD) and the latter phase decoherence (PD), then further conclude that both SD and PD result from phase wash-out effects of different phase structures on different layers. Such effects admit for simple numerical calculations of decoherence for a given width and shape of uncertainties. While our structure is generic, so are the uncertainties, nonetheless, a few notable ones are: the wavepacket size of the external particles, the effective interaction volume at production and detection, the energy reconstruction model and the neutrino production profile. Furthermore, we estimate the experimental sensitivities for SD and PD, parameterized by the uncertainty parameters, for reactor neutrinos and decay-at-rest neutrinos, using a traditional rate measuring method and a novel
phase measuring method.

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