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Energy conserving scenarios in neutrino decoherence

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Experimental results over the past three decades strongly favour the standard three-flavour oscillation framework, based on the coherent propagation of neutrinos in vacuum and matter. However, neutrinos may interact in more complex and unknown ways. In this regard, subleading effects such as a weak coupling to an external environment can be explored by treating neutrinos as an open quantum system, allowing one to assess their possible impact on oscillation physics. For a model-independent treatment, we analyze neutrino evolution using the Gorini–Kossakowski–Sudarshan–Lindblad (GKSL) master equation in a vectorized form with phenomenologically motivated parameters.

In this work, we focus on evaluating the expectation value of the Hamiltonian $\langle H \rangle$ and its derivative $\langle \dot{H} \rangle$ o quantify how decoherence parameters modify the absolute energy and the oscillation probabilities. Within this framework, we identify classes of non-diagonal, energy-conserving decoherence matrix textures that remain unexplored in the literature. Furthermore, we analyze CP- and CPT-violating effects in neutrino propagation induced by these scenarios.

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