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Analytical treatment of neutrino oscillation and decay in matter

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We present compact analytical expressions for neutrino oscillation probabilities, in the presence of invisible neutrino decay, where matter effects have been explicitly included. The probabilities are obtained both in the 2-flavor and 3-flavor formalisms.

The inclusion of decay leads to a non-Hermitian effective Hamiltonian, where the Hermitian component represents oscillation, and the anti-Hermitian component corresponds to invisible decay of neutrinos. These two components may not commute, leading to a mismatch between the effective mass eigenstates and the decay eigenstates of neutrinos. Even if these components commute in vacuum under certain scenarios, they will invariably become non-commuting due to matter effects.

We overcome this by employing the techniques of inverse Baker-Campbell-Hausdorff (BCH) expansion, and the Cayley-Hamilton theorem applied in the 3-flavor framework. We also obtain the probabilities in the One Mass Scale Dominance (OMSD) approximation. The analytical results thus obtained provide physical insights into possible effects of neutrino decay as it propagates through Earth matter. These results may be used for long-baseline or atmospheric neutrino oscillation experiments. We also point out certain non-intuitive features of the neutrino oscillation probability in the presence of decay, and explain them using our analytical approximations.

In-person participation

Yes

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