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Probing the non-standard neutrino interactions using quantum statistics

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We present a completely general, model-independent formalism to probe the possible nonstandard couplings of (Dirac and Majorana) neutrinos. The proposed methodology is based on the different quantum statistical properties of the Dirac and Majorana neutrinos which, contrary to neutrinomediated processes of lepton number violation, could lead to observable effects not suppressed by the small ratios of neutrino and heavier particle masses. For processes with a neutrino-antineutrino pair of the same flavor in the final state, we formulate the "Dirac Majorana confusion theorem (DMCT)"showing why it is normally very difficult to observe the different behaviour of both kinds of neutrinos in experiments if they have only the standard model (SM)-like left-handed vector couplings to gauge bosons. We discuss deviations from the confusion theorem in the presence of non-standard neutrino interactions, allowing to discover or constrain such novel couplings. We illustrate the general results with two chosen examples of neutral current processes, $Z \longrightarrow \nu\ \nu$ and $Pi \longrightarrow Pf\ \nu\ \nu$ (with Pi,f denoting pseudoscalar mesons, such as B,K,π). Our analysis shows that using 3-body decays the presence of non-standard interactions can not only be constrained but one can also distinguish between Dirac and Majorana neutrino possibilities.

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