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TALK: Exploring Quantum Statistics for Dirac and Majorana Neutrinos using Spinor-Helicity techniques

Friday, July 11, 2025 1:15 PM (45 minutes)

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Abstract: Recently, there has been interest in the applicability of quantum statistics to distinguish Dirac from Majorana neutrinos in multi-neutrino final states. In particular, debate has arisen over the validity of the Dirac-Majorana confusion theorem in these processes, i.e., that any distinction between the Dirac and Majorana processes goes to zero as the neutrino mass goes to zero. Here we approach this problem equipped with spinor-helicity methods generalized for massive Dirac and Majorana fermions. We explicitly calculate all helicity amplitudes for the decay of a light scalar particle to two neutrinos and two oppositely charged leptons. This allows us to pinpoint the crucial steps which could lead to claims of a violation of the confusion theorem. We show that if the correct anti-symmetrization of Dirac to Majorana amplitudes is used, identification of which is clear in this framework, and all relevant contributions are appropriately summed, a scalar decay into two charged leptons and two neutrinos satisfies the Dirac-Majorana confusion theorem.

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