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Double Beta Decay as a Probe of New Physics

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The study of nuclear double beta decay provides a uniquely sensitive window into physics beyond the Standard Model. While the two-neutrino mode, a rare second-order weak process, has been observed in several isotopes, the search for the neutrinoless mode remains a paramount objective in particle and nuclear physics. The observation of this decay would be a landmark discovery, as it violates total lepton number conservation and would definitively establish that neutrinos are Majorana particles. This talk will review the profound theoretical motivations for searching for double beta decay. Beyond the standard mass mechanism where light, active Majorana neutrinos are responsible for the decay, I will also explore how these searches constrain other Beyond-the-Standard-Model scenarios, such as non-standard neutrino interactions, sterile neutrinos, Majorons and other dark sector particles coupling to neutrinos. Here, I will highlight the importance of the measured two-neutrino mode, solidifying the role of double beta decay as a powerful and essential probe of New Physics.

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