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Searches for Neutrino-less Double Beta-Decay: a Decade of Discovery Ahead at the ton-scale?

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Double beta-decay with the emission of neutrinos is an allowed second-order process and has been observed in several candidate nuclei such as 76Ge, 82Se, and 136Xe. A neutrino-less decay mode is theoretically possible as well, with profound implications such as non-conservation of lepton number. The neutrino-less decay can only occur if the neutrino and anti-neutrino are identical, and the neutrino has non-zero mass. The discovery of neutrino oscillations has guaranteed a non-zero neutrino mass, and also provides a target range of desired sensitivity. Recent results have placed upper limits, all well above the desired sensitivity. New searches for the neutrino-less decay mode are being promoted that could span the possible neutrino mass range if the mass ordering is inverted. I will present a personal perspective on current experimental aspirations in the international context. To realize a 'discovery class' experiment at the ton-scale of active mass, however, the background levels observed in present experiments must be reduced by two orders of magnitude, probably more. Is this technically possible? For the US, an opportunity appears to exist in the use of gas-phase xenon, with development of new methods for background reduction. The elusive neutrino may yet provide more surprises, even insight as to why there is something, rather than nothing.

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