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Search for Lepton Number Violation and Neutrino Nature with Neutrinoless Double Beta Decay

WILLIAM FAIRBANK, Colorado State University

Despite nine decades of research on neutrinos, their fundamental nature remains a mystery. Two possibilities exist: (1) Dirac neutrinos, in which neutrinos and anti-neutrinos are different particles and (2) Majorana neutrinos, in which neutrinos and anti-neutrinos are the same particle. In the latter case, lepton number would have no meaning for neutrinos, and lepton-number nonconserving interactions could occur. One such process is neutrinoless double beta decay (0nbb), in which two electrons and no antineutrinos(Δ L=2) are emitted. If 0nbb decay is discovered, then neutrinos must be Majorana. I will give an overview the leading experiments giving half-life limits for 0nbb decay of up to 10^26 years and proposals for next-generation experiments with half-life sensitivity of 10^28 years. Of personal interest is the possibility of observing the Ba^136 daughter of one Xe^136 0nbb decay using single atom or single molecule imaging, which may allow even higher sensitivity to be achieved.