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Discovery Reach of Neutrinoless Double-Beta Decay

Neutrinoless double-beta decay ($0\nu\beta\beta$) is a lepton-number-violating nuclear process that, if observed, would provide direct evidence for Majorana neutrinos and insight into the absolute neutrino mass scale. The next generation of $0\nu\beta\beta$ experiments, employing a broad range of candidate isotopes, are designed to fully probe the inverted mass hierarchy and to extend sensitivity into the normal hierarchy. Recent cosmological indications favoring the normal hierarchy further motivate this effort, although probing this region remains challenging under the current theoretical uncertainties associated with nuclear matrix elements. Recognizing the critical impact of theoretical inputs on the design and interpretation of experimental searches, this work systematically incorporates uncertainties in nuclear matrix elements, the axial-vector coupling, and phase-space factors, particularly emphasizing nuclear matrix elements, spanning recent ab-initio and phenomenological nuclear-structure calculations, to evaluate the projected sensitivity of forthcoming $0\nu\beta\beta$ experiments.

Condensed Matter Physics

Not Applicable

High Energy Physics

Yes

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