Contribution ID: **36** Type: **Oral presentation**

Theoretical uncertainties and beyond-Standard-Model signatures in double-beta decay spectra

Wednesday, June 25, 2025 9:15 AM (30 minutes)

Double-beta decay provides a promising probe sensitive to physics beyond the Standard Model, especially due to its potential to uncover the Majorana nature of neutrinos. For interpreting data from current and next-generation double-beta decay experiments, including SuperNEMO –which will be capable of measuring not only energy spectra but also angular correlations of emitted electrons –it is of direct relevance to focus on very precise theoretical predictions. In this work, we perform a detailed analysis of the shapes of single and summed energy distributions, as well as angular correlations of the electrons emitted in double-beta decay, with particular emphasis on theoretical uncertainties arising from phase-space factor calculations and nuclear modelling. In particular, we focus on nuclear matrix element calculations, approximations for Dirac wave functions, and weak magnetism correction, and we investigate their impact on distinguishing the standard two-neutrino double-beta decay from new physics signals, such as neutrinoless double-beta decay accompanied by massive scalar emission.

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Session Classification: Theory

Track Classification: Theory