Contribution ID: **416** Type: **Oral**

Calculation and comparison of sensitivities in $0\nu\beta\beta$ experiments based on key parameters

Wednesday 27 August 2025 17:40 (20 minutes)

Worldwide efforts are underway to detect neutrinoless double beta ($0\nu\beta\beta$) decay using experiments based on various technologies and target isotopes. Future experiments in this regard aim to exclude the inverted order (IO) condition or explore the normal order (NO) band. Consequently, comparing the sensitivities of proposed $0\nu\beta\beta$ decay experiments with promising prospects is essential. The current study adopts sensitivity metrics, including exclusion and discovery sensitivities, half-life sensitivities, and mbb sensitivities, to provide a comprehensive evaluation of 10 typical promising experiments: LEGEND, CDEX, NEXT, nEXO, XLZD, PandaX, ,KamLAND-Zen, JUNO, SNO+, and CUPID, and highlight their unique features. Based on reported experimental parameters, the concept of a technical line is introduced to determine the location that each experiment may realize in the ξ andλ_b space, where ξ represents the sensitive exposure per year, and λ_b denotes the expected annual rate of background events. Half-life sensitivities for the selected experiments are calculated, some of them in multiple phases while others in conservative or aggressive condition. The results indicate that increasing the operation time is more benecial for zero-background experiments, which also demonstrate greater competitiveness in discovery sensitivity. mbb sensitivities are presented as uncertainty bands arising from the nuclear matrix element uncertainties. Additionally, half-life and mbb sensitivities are estimated under ideal conditions, where only background induced by $2\nu\beta\beta$ and elastic scattering of solar B-8 neutrinos remains. The upper limits of background reduction achievable with current experimental setups are also demonstrated.

Collaboration you are representing

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Authors: Prof. MA, Hao (Tsinghua University); Prof. WONG, Henry; Prof. YANG, Litao (Tsinghua University); Prof. YUE, Qian (Tsinghua University); YU, Xiao (Tsinghua University)

Presenter: YU, Xiao (Tsinghua University)

Session Classification: Neutrino Physics and Astrophysics

Track Classification: Neutrino Physics and Astrophysics