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(G*) Constraining fundamental physics via nuclear theory

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Recent analysis of Fermi decays by C.Y. Seng and M. Gorshteyn and the corresponding V_{ud} determination have revealed a degree of tension with Cabibbo-Kobayashi-Maskawa (CKM) matrix unitarity, confirmation of which would indicate several potential deficiencies within the Standard Model (SM) weak sector. Extraction of V_{ud} requires electroweak radiative corrections (EWRC) from theory to be applied to experimentally obtained ft-values. Novel calculations of corrections sensitive to hadronic structure, i.e., the γW-box, are at the heart of the recent tension. Moreover, to further improve on the extraction of V_{ud}, a modern and consistent treatment of the two nuclear structure dependent corrections is critical. These corrections are (i) δ_C, the isospin symmetry breaking correction (ii) and δ_{NS}, the EWRC representing evaluation of the γW-box on a nucleus. Preliminary estimations of δ_{NS} have been made in the aforementioned analysis, however, the approach cannot include effects from low-lying nuclear states which require a true many-body treatment. Via collaboration with C.Y. Seng and M. Gorshteyn and use of the Lanczos subspace method, these corrections can be computed in ab initio nuclear theory for the first time. We apply the no-core shell model (NCSM), a non-relativistic quantum many-body theory for describing low-lying bound states of s- and p-shell nuclei starting solely from nuclear interactions. We will present preliminary results for δ_{NS} and δ_C determined in the NCSM for the $^{10}\mathrm{C} \rightarrow {}^{10}\mathrm{B}$ beta transition, with the eventual goal of extending the calculations to $^{14}\mathrm{O} \rightarrow {}^{14}\mathrm{N}$ and $^{18}\mathrm{Ne} \rightarrow {}^{18}\mathrm{F}$.

Keyword-1

Fundamental symmetries

Keyword-2

Standard Model

Keyword-3

Nuclear many-body theory

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