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Constraining fundamental physics from ab initio nuclear theory

Recent global analysis of Fermi decays within a dispersion relation framework and the corresponding V_{ud} determination have revealed tension with the Standard Model (SM) expectation of Cabibbo-Kobayashi-Maskawa (CKM) matrix unitarity, theoretical confirmation of which would indicate a deficiency within the SM weak sector. Extracting V_{ud} requires electroweak radiative corrections (EWRC) from theory to be applied to the experimentally obtained ft-values. Novel calculations of the pieces 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) δ_{NS}, the EWRC representing evaluation of the γW-box on a nucleus. Preliminary estimations of δ_{NS} have been made in the dispersion relation framework, 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 continued fraction method, these corrections are now calculable within the ab initio no-core shell model (NCSM). The NCSM is a nonrelativistic 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 $^{18}\mathrm{Ne} \rightarrow {}^{18}\mathrm{F}$.

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