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High-Precision Study of the Superallowed Fermi Beta Emitter ^{62}Ga

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High-precision measurements of the ft values for superallowed Fermi beta decays between 0^+ isobaric analogue states have provided invaluable probes of the Standard Model description of the electroweak interaction. Theoretical corrections must be applied to the experimentally determined ft values obtained from precise measurements of the half-lives, branching ratios, and Q values of the decays. Of particular interest is the isospin symmetry-breaking correction, δ_C, which is nuclear-structure-model dependent; several theoretical approaches can and have been used to calculate these corrections with varying results. In the most recent survey of superallowed Fermi β emitters [1] the selection of a particular δ_C model depended significantly on four of the least precisely determined corrected-ft values: ^{22}Mg, ^{38}Ca, ^{62}Ga, and ^{74}Rb for the well-measured cases.

Recently, updated calculations of the universal "inner" electroweak radiative correction, Δ_R^V, have been performed [2-4]. This value is used in combination with the corrected superallowed $\mathcal{F}t$ values to extract such quantities as G_V, the vector coupling constant, and $|V_{ud}|$, the most precisely determined element of the CKM quark mixing matrix. With the updated value of Δ_R^V, the first row of the CKM quark mixing matrix now disagrees with unitarity at the 2-4σ level, prompting an increased interest in re-investigating the model-dependent nuclear structure corrections, especially those which can be directly constrained experimentally.

We have performed a high-statistics experiment for the superallowed Fermi β^+ emitter ^{62}Ga at the Isotope Separator and Accelerator (ISAC) radioactive ion beam facility at TRIUMF using the high-efficiency Gamma-Ray Infrastructure for Fundamental Investigations of Nuclei (GRIFFIN) spectrometer. The high coincidence efficiency of the GRIFFIN spectrometer allowed for a significant expansion of the level scheme, more than doubling the known γ-ray transitions in the daughter nucleus, ^{62}Zn. This allowed a new measurement of the superallowed branching ratio with a precision of $\pm$0.0012\%, $\sim$6 times more precise than previously achieved [5]. Gamma-ray intensities were measured down to the 1 ppm level, effectively solving the Pandemonium problem [6] for ^{62}Ga. For one particularly important cascade, sufficient statistics were obtained to perform a $\gamma - \gamma$ angular correlation measurement. This allowed the previously-conflicting spin-assignments for the 2.34˜MeV excited state in ^{62}Zn [7,8] to be resolved and firmly established this state to have $J^\pi = 0^+$. The assignment of the spin of this state has important implications for the isospin symmetry breaking correction, δ_{C1}. Final results from this analysis will be presented.

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