High-precision half-life and branching ratio measurements for superallowed Fermi β^+ emitters at TRIUMF – ISAC

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High-precision measurements of the ft values for superallowed Fermi β transitions between nuclear analog states of spin $J^\pi = 0^+$ and isospin $T = 1$ provide demanding, and fundamental, tests of the properties of the electroweak interaction. These transitions directly probe the vector weak current and can be used to constrain the presence of induced or fundamental weak scalar currents. The measurement of the ft values for superallowed β emitters have been used to validate the conserved vector current (CVC) hypothesis to better than 2 parts in 10^4, as well as provide the most precise determination of V_{ud}, by far the most precisely measured element of the Cabibbo-Kobayashi-Maskawa (CKM) matrix and essential for testing CKM unitarity—a fundamental property of the electroweak Standard Model [1].

A program at TRIUMF's Isotope Separator and Accelerator (ISAC) facility is in place to perform high-precision half-life and branching ratio studies for several of these superallowed β emitters. These experiments are performed using both a 4π gas proportional β counter and the 8π γ-ray Spectrometer, a spherically symmetric array consisting of 20 Compton-suppressed High-Purity Germanium (HPGe) detectors, and its ancillary detection systems such as the Zero-Degree Scintillator, the Scintillating Electron-Positron Tagging Array, and the Pentagonal Array for Conversion Electron Spectroscopy.

These experiments also provide demanding tests of the theoretical corrections necessary to account for isospin symmetry breaking effects in superallowed decays as well as setting limits on scalar currents in beta decay, where the low-Z superallowed decays are most sensitive to a possible scalar current contribution. In particular, this presentation will focus on recent highlights from high-precision half-life and branching ratio measurements for the superallowed emitters ^{26}Al^m [2, 3], ^{74}Rb [4], and ^{14}O [5].

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