THE ISOBARIC MULTIPLET MASS EQUATION AND ft VALUE OF THE $0^+ \rightarrow 0^+$ FERMI TRANSITION IN ^{32}Ar: TWO TESTS OF ISOSPIN SYMMETRY BREAKING

Abstract

by

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This dissertation describes two high-precision measurements concerning isospin symmetry breaking in nuclei.

1. We determined, with unprecedented accuracy and precision, the excitation energy of the lowest $T = 2$, $J^\pi = 0^+$ state in ^{32}S using the ^{31}P(p, γ) reaction. This excitation energy, together with the ground state mass of ^{32}S, provides the most stringent test of the isobaric multiplet mass equation (IMME) for the $A = 32$, $T = 2$ multiplet. We observe a significant disagreement with the IMME and investigate the possibility of isospin mixing with nearby 0^+ levels to cause such an effect. In addition, as byproducts of this work, we present a precise determination of the relative γ-branches and an upper limit on the isospin violating branch from the lowest $T = 2$ state in ^{32}S.

2. We obtained the superallowed branch for the $0^+ \rightarrow 0^+$ Fermi decay of ^{32}Ar. This involved precise determinations of the beta-delayed proton and γ branches. The γ-ray detection efficiency calibration was done using precisely determined γ-ray yields from the daughter ^{32}Cl nucleus from another independent measurement using a fast tape-transport system at Texas

A&M University. This superallowed branch, along with previously determined half-life and Q_{EC} value measurements, provides the ft value for the decay. On comparison with the ft values of nine previously measured $T = 1 \rightarrow T = 1$ Fermi transitions, this provides a useful check of calculated isospin breaking corrections, which, in the case of ^{32}Ar, is ≈ 3 times larger than the nine measured cases. The calculated corrections for nuclear β decays play an important role in determining V_{ud}, the first element of the CKM matrix.