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Beta-decay as a probe of the isospin doublet in 8Be

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Since the mid-60s, the presence of a 2^+ doublet in ^{8}Be, constituted by the 16.6 and 16.9 MeV excited states, has been observed [1-3]. An intriguing aspect of this doublet is its status as the best-known instance featuring a complete isospin mixing, where the 16.6 MeV (^{7}Li+p) and 16.9 MeV (^{7}Be+n) levels can be decomposed in an equal mixture of two pure isospin (T=0 and T=1) levels [4]. While indications of this behaviour have hinted through R-Matrix fits in reaction experiments [5], direct confirmation is still pending.

The 2^+ isospin doublet in ^{8}Be, comprising the 16.6 and 16.9 MeV excited states, has been consistently observed [1-3] since the mid-1960s, through reaction experiments. Notably, this doublet stands out as the most well-known instance of a total isospin mixing, where the 16.6 MeV (^{7}Li+p) and 16.9 MeV (^{7}Be+n) levels exhibit an equal mixture of two pure isospin (T$=0$) and (T$=1$) states [4]. While R-Matrix fits in reaction experiments have hinted at this behaviour [5], direct confirmation remains pending.

The beta decay of the 1-proton halo nucleus ^{8}B into ^{8}Be offers a valuable avenue for probing the isospin composition of the doublet through selective Fermi and Gamow-Teller components. However, resolving the feeding to the 2^+ doublet poses challenges. Within the Q_{EC} window (Q_{EC} = 17.9798(1)\) MeV), the predominant ($\geq$ 88 %) decay mode leads to a broad \(2^+) state at 3 MeV [6], extensively studied due to its significance as a primary source of high-energy solar neutrinos [7]. Additionally, beta decay can occur via electron capture (EC) at 17,640 MeV. Assuming the EC decay occurs in the core with the halo proton as a spectator, the strength of this unobserved branch is estimated from the decay of ^{7}Li to be a branching ratio of \($2.3 * 10^{-8}$)[8].

The IS633 experiment, conducted by the MAGISOL collaboration at the CERN/ISOLDE facility's decay station (IDS), is focused on investigating the 2^+ doublet of ^{8}Be through the beta decay of ^{8}B [9,10]. A mass-separated 50 keV $^8BF_2$ beam was implanted in a (30, mg/cm^2) carbon foil catcher. Through EC/(β^+) decay, ^{8}B feeds the excited states of ^{8}Be, which subsequently break up into two α particles or a proton and a ^{7}Li, depending on the level fed. Detection of the breakup fragments is done through a system of particle telescopes, each comprising a Double-Sided Silicon Strip Detector (DSSD) stacked with a thick Si-PAD detector. These telescopes, arranged in pairs of opposite-facing detectors, enabled precise data collection.

IS633 represents a significant advancement, achieving a two-order-of-magnitude improvement in statistics over the preceding benchmark experiment JYFL08 [9]. High-statistics data from IS633 enabled the resolution of the continuum spectrum of ^{8}Be from 1 MeV up to 17 MeV. Notably, the 16.6 MeV and 16.9 MeV doublet were resolved for the first time in a beta decay study.

This contribution provides a comprehensive description of experiment IS633, including the analysis of excitation spectra using R-matrix methods and an alternative approach based on beta recoil. These complementary analyses have facilitated the determination of isospin mixing in the doublet and the identification of the Fermi and Gamow-Teller components.

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