Isospin mixing in N $\approx$ Z nuclei

P. Schuurmans[1], M. Beck[1], B. Delauré[1], T. Phalet[1], N. Severijns[1], D. Srnka[2], D. Vénos[2], B. Vereecke[1], S. Versyck[1], D. Zákoucký[2] and the NICOLE and ISOLDE collaborations.
[1] *Instituut voor Kern- en Stralingsfysica, University of Leuven, B-3001 Leuven, Belgium.*
[2] *Institute for Nuclear Physics, ASCR, 250 68 Řež, Czech Republic.*

Isospin impurities occur when nuclear states with $T \neq T_0$ are mixed into states with $T = T_0$. It is predominantly caused by the Coulomb interaction but possibly also by charge dependent terms in the nucleon nucleon interaction. In the N = Z region isospin mixing is enhanced because of the increased overlap between the neutron and proton wave functions. From an experimental point of view interest in isospin mixing has been triggered by the development of accelerated heavy ion beams and the production of doubly magic N = Z nucleus ^{100}Sn [1]. Here isopin mixing should increases because of the stronger Coulomb interaction in heavier nuclei. The understanding of isospin mixing is also important in tests of the Standard Model of electroweak interactions. Particular tests of the Conserved Vector Current (CVC) hypotheses and the unitarity of the Cabibbo-Kobayashi-Maskawa (CKM) quark mixing matrix use the $ft-$ values of the supperallowed $0^+ \rightarrow 0^+$ Fermi transitions which are subject to radiative (δ_R) and isospin-impurity (δ_c) corrections. Using data from [2] it is found that there is a deviation from unity by 2 to 2.3 σ, or that unitarity of the CKM matrix is excluded at the 95% confidence level [3]. A possible explanation for this situation might be found in an underestimation of the isospin mixing corrections δ_c in the determination of the dominant V_{ud} matrix element.

Theoretical calculations of $\Delta T = 1$ isospin mixing have been performed using the shell model with an empirical nucleon-nucleon interaction [4] and using the Hartree-Fock method with Random Phase Approximation [5-6]. Experimentally, isospin mixing in N $\approx$ Z can be determined by observing $E1$ γ decays or Fermi β transitions, both of which may vanish in the absence of isospin mixing. For $E1$ γ decay this is only the case when $N = Z$ ($T_0 = 0$). Fermi β decay on the other hand is also sensitive to isospin mixing when $T_0 \neq 0$ implying that also $N \approx Z$ nuclei can be investigated. Because isospin mixing is only appreciable in proton-rich nuclei, only β^+ decay is involved. By comparing the selection rules for allowed Fermi ($\Delta J = 0$; $\Delta T = 0$) and Gamow-Teller ($\Delta J = 0, 1$ ($0 \not\rightarrow 0$); $\Delta T = 0, 1$) β decay, it is clear that the observation of a Fermi component in a $J^\pi \rightarrow J^\pi$, $\Delta T = 1$ transition implies isospin mixing as the Fermi strength can only originate from a $\Delta T = 0$ contribution. In fact, the Fermi matrix element M_F directly yields the isospin mixing amplitude α.

Here we report on an experimental study of isospin mixing in the ground states of ^{52}Mn ($T = 1$) and ^{71}As ($T = 5/2$) via anisotropic positron emission from oriented nuclei. The β^+ asymmetry experiments were performed by low-temperature nuclear orientation. To reduce the influence of β scattering, β spectra were recorded with cooled (8 K) Si PIN diodes and planar Ge detectors looking directly at the sample. In addition, particular care was taken to ensure the purity of the radioactive sources. By combining the measured positron asymmetry parameter with the experimental $ft-$ value the magnitude of the isospin forbidden Fermi matrix element in the Gamow-Teller dominated β decay was determined. From that, the isospin mixing amplitude was deduced. Comparison with theoretical calculations show that the HF+RPA overestimate the isospin mixing probability by more than two orders of magnitude.

[1] R. Schneider *et al.,* Z. Phys. A **348**, 241 (1994) ; M. Lewitowicz *et al.,* Phys. Lett. B **332**, 20 (1994).
[2] C. Caso *et al.,* Eur. Phys. Jour. C **3**, 1 (1998).
[3] H. Sagawa, Nguyen Van Giai and Toshio Suzuki, Phys. Rev. C **53**, 2163 (1996); J.C. Hardy and I.S. Towner, *Int. Conf. on Exotic Nuclei and Atomic masses,* Bellaire (Michigan-USA) June 23-27, 1998 eds. B.M. Sherrill, D.J. Morrisey and C.N. Davids (AIP CP455 Woodbury, New York) 733 (1998).
[4] C. Yalcin and C.T. Yap, Nucl. Pys. A **153**, 424 (1970); G.P. Bertsch and B.H. Wildenthal, Phys. Rev. C **8**, 1023 (1973).
[5] I. Hamamoto and H. Sagawa, Phys. Rev. C **48**, R960 (1993).
[6] G. Colò, M.A. Nagarajan, P. Van Isacker and A. Vitturi, Phys. Rev. C **52**, R1175 (1995).