Isospin mixing at finite temperature in ^{80}Zr

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In the isospin formalism, neutrons and protons are assumed to be different states of the nucleon with values 1/2 and -1/2 of the projection I_z of the isospin operator I.
Isospin symmetry is largely preserved by nuclear interactions and the main violations of isospin symmetry are due to Coulomb interaction. The effect of isospin symmetry violation is that isospin is not a completely good quantum number for the nucleus, but in many cases this effect can be neglected or is small enough to be treated in a perturbative way.
In general, the breaking of isospin symmetry can be observed through the decays which would be forbidden by the selection rules if isospin mixing was not to occur. For example the neutron decay from the IAS or of the E1 decay from self-conjugate nuclei.
The giant dipole resonance (GDR) is an excitation mode where the selection rule of E1 decay can be fully exploited. Fusion-evaporation reactions allow the production of self-conjugate compound nuclei (CN) at high excitation energy which, in many cases, are far from the β-stability valley. The use of a self-conjugate projectile and target ensures that the CN produced in fusion reactions has isospin $I = 0$. Therefore, E1 emission associated with the decay of the GDR is hindered due to the fact that, if the isospin of the initial state is pure, only the less-numerous $I = 1$ final states can be reached in the decay. Conversely, if the initial state is not pure in isospin but contains an admixture of $I = 1$ states, it can decay to the more numerous $I = 0$ final states. The most direct consequence is that the first-step γ yield depends on the degree of isospin mixing of the CN. In addition, at a finite temperature one expects a partial restoration of the isospin symmetry because the degree of mixing in a CN is limited by its finite lifetime for particle decay. The competition between the timescale of the Coulomb-induced mixing and the CN lifetime (which decreases for increasing temperature) drives toward a restoration of isospin symmetry, as already predicted by Wilkinson in 1956.
Isospin mixing in the hot compound nucleus ^{80}Zr was studied by measuring and comparing the gamma-ray emission from the fusion reactions ^{40}Ca+^{40}Ca at E_{beam}= 136 MeV and ^{37}Cl+^{44}Ca at E_{beam}=95 MeV . The yield associated with the Giant Dipole Resonance is found to be different in the two reactions because in self-conjugate nuclei the E1 selection rules forbid the decay between states with isospin I=0.
The experiment was performed at the INFN Laboratori Nazionali di Legnaro using the AGATA-HECTOR array system for the measurement of high and low energy gamma-rays and.
The reaction which has produced the ^{81}Rb hot compound nucleus was used to select the GDR and the statistical model parameters. The degree of mixing at high temperature was deduced from statistical model analysis of the gamma-ray spectrum emitted by the compound nucleus ^{80}Zr.
The results are used to deduce the zero temperature value which can be compared with very recent theoretical predictions. The Coulomb spreading width is found to be independent of temperature and identical to the width of the ground state IAS.