Spin-Isospin Excitations and Nuclear Muon Capture

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Recently the results of several experiments which observe the γ rays following the muon capture in nuclei were published [1]. We will show that similar experiments may give important contribution to the studies of the distribution of Gamow-Teller transition strength over the excitation energy. Distributions of the transition strength of spin-isospin operators $\left(\sum_{k=1}^{A} \sigma_k t_k^{\pm,0}\right)$ over the excitation energy in nuclei are studied experimentally in electromagnetic and hadronic processes [2]. In many nuclei the distribution of the reduced probability of GT transition, B^-(GT), over the excitation energy calculated within the Random Phase Approximation agreed well with the distributions extracted from the experimental cross sections of (p, n) reaction. The only discrepancy was found that experimental B(GT) summed over all states forms approximately 60% of the corresponding theoretical strength (the so-called effect of *missed* or *quenched* GT strength) [2]. It was shown that the shift of the GT strength to higher energies (assumed by the effect of the missed strength) should be produced by the interaction among the one-particle–one-hole states ($1p$–$1h$) only [3, 4]. The interaction should mix the states in which the particle and hole levels are from the one major shell, $\Delta N = 0$ states, and the $1p$–$1h$ states with particle and hole from different major shells, $\Delta N \geq 2$ states. This specific feature of a nuclear effective spin-isospin interaction is necessary to explain the GT strength missing.

Such a feature of the residual interactions must also manifest itself in other processes with spin-isospin transitions involved. The calculations [5] show that the total rate of ordinary muon capture (OMC) in nuclei depends mainly on spin-multipole nuclear transitions. The calculations performed for medium nuclei (^{58,60,62}Ni, ^{90}Zr, and $^{116-124}$Sn) with different residual interactions yield practically the same values of the total OMC rates, which are in good agreement with experimental data. In heavier nuclei (^{140}Ce and ^{208}Pb) theoretical total OMC rates exhibit a noticeable dependence on the residual interactions and considerably exceed experimental values. The discrepancy between the theory and experiment becomes the largest if the residual interaction, which mixes the $\Delta N = 0$ and $\Delta N \geq 2$ particle-hole states, was used [5]. Transitions to the high-lying 1^+ states provide the largest part of the excess. If one can extract from the the experiment on muon capture in ^{208}Pb which part of total rates was produced by the transitions to the states of product nuclei with excitation energy more that 20 MeV, he will test the nuclear residual interaction. And it will be independent test for the effect of missed GT strength.

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