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Beta Decay of Exotic T_Z = -1, -2 Nuclei: the Interesting Case of ^{56}Zn

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Beta decay is a powerful tool to investigate the structure of nuclei far from the line of β-stability, giving direct access to the absolute value of the Gamow-Teller transition strength *B*(GT). However the finite Q_β value only allows access to states at low excitation energy.

On the other hand, Charge Exchange (CE) studies, at intermediate beam energies and zero momentum transfer, allow the determination of relative *B*(GT) values up to high excitation energy. Thus beta decay and CE reactions complement each other [1].

Under the assumption of isospin symmetry, the beta decay of proton-rich nuclei and CE reactions carried out on the mirror stable nuclei can be combined to determine the absolute *B*(GT) strength up to high excitation energies. Absolute *B*(GT) values can be determined even for GT transitions starting from extremely unstable nuclei if the beta-decay half-life and the Q_β value are precisely known. This "merged analysis" [1] method has been successfully employed in a series of experiments involving proton-rich nuclei in the *fp*-shell having T_Z = -1 [1, 2].

These results have instigated further investigations on more exotic nuclei above the *fp*-shell and the study of the T_Z = -2 case. The half-lives of the T_Z = -2, ^{56}Zn isotope and other nuclei with T_Z = -1 and -2 were measured in a beta-decay experiment performed at the LISE3 facility of GANIL. The fragmentation of a 74.5 MeV/u $^{58}Ni^{26+}$ primary beam on a natural Ni target was used for the ion production. The β^--type mirror CE reaction on the T_Z = +2, ^{56}Fe target nucleus was carried out at RCNP Osaka [1] using the (^{3}He,*t*) reaction at 140 MeV/u and $\vartheta = 0°$.

The decays of T_Z = -1 and T_Z = -2 proton-rich nuclei in the *fp*-shell show some important differences. Essentially only beta-delayed gamma emission is observed for T_Z = -1 nuclei. The decay of the T_Z = -2 nuclei is more complex because both beta-delayed gamma rays and beta-delayed proton emission are present, due to the extremely low proton separation energy. In particular, ^{56}Zn is a very interesting case. The decay mainly proceeds by proton emission, but gamma emission was also detected. Moreover, an exotic and perhaps unique feature was observed, namely a beta-delayed gamma-proton decay. The ^{56}Zn results are compared with the results of the mirror process, the CE ^{56}Fe(^{3}He,*t*)^{56}Co reaction.

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