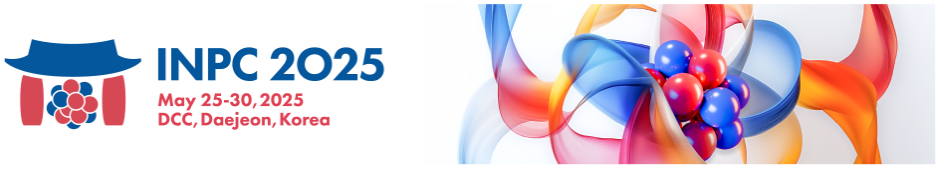

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The beta-decay properties of N=Z nuclei: Role of neutron-proton pairing and the shell model interpretation

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The structure and decay properties of neutron-deficient nuclei along the $N = Z$ line have been one of the most important focal points of nuclear physics studies. An essential feature of nuclear structure that can affect the β decay of $N = Z$ nuclei is the pairing correlation [1,2]. From the recent experimental measurement [3], an enhancement in GT transition strength for the β-decay of ^{70}Br in comparison to the decay of ^{62}Ge was observed, which was suggested as an indication of increased np pairing. Along the $N = Z$ line, we have performed detailed shell model calculations for four different transitions: ^{58}Zn ($0^+_{\text{g.s.}}$) $\rightarrow$ ^{58}Cu, ^{62}Ge ($0^+_{\text{g.s.}}$) $\rightarrow$ ^{62}Ga, ^{66}Se ($0^+_{\text{g.s.}}$) $\rightarrow$ ^{66}As, and ^{70}Kr ($0^+_{\text{g.s.}}$) $\rightarrow$ ^{70}Br. The purpose of this work is to study the GT decays to odd-odd $N = Z$ nuclei and identify the role played by the isovector as well as isoscalar np interactions.

First, we have determined the impact of pairing on GT transitions using the surface delta effective interaction with only $J = 1, T = 0$ and $J = 0, T = 1$ pairing matrix elements in the model space $p_{3/2}p_{1/2}f_{5/2}$. Even though the interaction is relatively simple, it gives a precise control on the phases of different components of the wave function and separates contributions from different single-particle orbitals to the total B_{GT}. Based on the results, we can conclude that the B_{GT} between yrast 0^+ and 1^+ states doesn't necessarily increase with increasing np pairing strength. That is partly due to the fact that the GT transitions are highly selective and only connect states with the same l value. Further, we have extended our model space by including $g_{9/2}$ orbital and performed the schematic calculations in $f_{5/2}pg_{9/2}$ model space. With the inclusion of the $g_{9/2}$ orbital, the GT strength can be increased with increasing np pairing in connection with the enhanced contribution from the $g_{9/2}$ orbital.

We have compared the schematic results with realistic calculations in the fp and $f_{5/2}pg_{9/2}$ model space, to gauge the contribution from $f_{7/2}$ and $g_{9/2}$ orbitals in the GT strengths. With JUN45 interaction [4], there is an increment for yrast 1^+ state for the decay of ^{70}Kr as compared to the decay of ^{62}Ge due to increased $g_{9/2}$ contribution. The total accumulated B_{GT} strength increases for GXPF1J interaction [5]. Additionally, we investigate the effect of np pairing on B_{GT} by modifying the single-particle energies and the $T = 0$ matrix elements of the interaction responsible for the decay transition strength. We found an increment in cumulative GT transition strength with increased np pairing matrix elements using GXPF1J interaction. The accumulated B_{GT} strengths are rather well reproduced but the decay to the low-lying states can be sensitive to the contributions from the deep-lying $f_{7/2}$ and higher-lying $g_{9/2}$ orbitals.

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