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Beta decay strength of ^{78}Ni to neutron-unbound states revealed by ^{79}Cu

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^{78}Ni is one of the few radioactive doubly-magic nuclei on the nuclear landscape [1]. It has a large neutron-to-proton ratio and engages in beta-delayed neutron and gamma emissions. Decays of Cu isotopes with significant neutron excess provide a laboratory to study such doubly-magic nuclei. The nuclear shell structure of ^{79}Cu (N=50; Z=29) is highly similar to the one of ^{78}Ni (N=50; Z=28), except an extra proton above the Z=28 shell gap in $1f_{5/2}$ orbital [2]. The similarities in the nuclear shell structure are also reflected in the beta decay properties. ^{79}Cu is also a strong beta-delayed neutron emitter, which allows us to infer beta-strength function $(S_\beta(E))$ to neutron-unbound states in the beta decay of ^{78}Ni.

The determination of $(S_\beta(E))$ requires measurement of the intensity of neutron resonances post beta decay. Neutron-gamma coincidences are also vital to arranging strength with excitation energy. An experiment for measuring the strength distribution in the ^{78}Ni region (27$\geq$Z$\geq$33) was performed at the Radioactive Ion Beam Factory (RIBF) facility at RIKEN Nishina Center, JAPAN using a YSO-based implantation detector [3] and VANDLE [4] array for Time-of-Flight-based spectroscopy of the beta-delayed neutrons. For γ-ray detection, two HPGe clovers and 10 $LaBr_3$ detectors were used.

This work reports the first direct measurements of beta-decay strength to neutron-unbound states in the decay of ^{81,80,79}Cu crossing over the N=50 shell closure. The results from the experiment are compared to NuShellX [5] calculations with various sets of single-particle energies and residual interactions. Finally, ^{78}Ni beta decay is predicted based on the model best describing ^{79}Cu. The results reveal neutron and proton spin-orbit partners providing significant contributions to $(S_\beta(E))$ in the beta decay of ^{78}Ni. The results also reveal the impact of the N=50 on the shell gap in the decay of ^{80,81}Cu.

References

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