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Experimental determination of the 3-neutron evaporation cross section to produce 29S in 20Ne+12C fusion-evaporation reaction

Isospin symmetry implies that the nuclear force is nearly equal between the proton-proton, neutron-neutron and proton-neutron pairs in the atomic nucleus. To probe this symmetry, one may study the so-called ''mirror nuclei" that have interchanged numbers of protons and neutrons, and thus should have analogue structures. The difference in excitation energy of the states characterized by the same isospin quantum number in mirror nuclei, called mirror energy differences (MED), are signatures of isospin symmetry breaking [1].
The investigation of isospin symmetry is commonly performed by studying nuclei located at and around the N=Z line. However, the proton-rich members of the mirror pairs are challenging to produce experimentally in fusion-evaporation reactions as the production cross sections drop drastically for pure neutron evaporation channels. Moreover, experimental cross-section data for pure neutron evaporation channels are scarce and the fusion-evaporation codes, such as HIVAP, PACE4 and GEMINI++ are known to overestimate the neutron-evaporation cross sections by few orders of magnitude. For these reasons, choosing the optimal beam energy to maximize the yield of the exotic proton-rich nucleus becomes complicated.
In a recent experiment performed at the Accelerator Laboratory of the University of Jyväskylä (JYFL-ACCLAB), the T_z=$-3/2$ nucleus ^{29}S was studied with the MARA [2] separator and the JUROGAM III [3] germanium array. The ^{29}S nuclei were produced in the ^{20}Ne+^{12}C$\rightarrow$^{29}S+$3n$ fusion-evaporation reaction with four different effective beam energies. The ^{29}S evaporation residues were unambiguously identified at the MARA focal plane by exploiting the characteristic β-delayed proton emission decay mode of this nucleus. In addition to the new γ-ray spectroscopy results for ^{29}S, the experimental production cross section values for this nucleus could be determined. This same technique will be exploited to measure the 3-neutron evaporation cross section for the other proton-rich nuclei in the mass region, such as ^{37}Ca and ^{45}Cr, for which experiments are going to be performed at JYFL-ACCLAB in spring 2025.
In this presentation, the newly obtained experimental cross section values for ^{29}S, and possibly for the other two proton-rich nuclei, will be presented and compared to the predictions obtained from the different fusion-evaporation simulation codes.

References

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