Progress on the analysis of P_n-values relevant for the formation of the r-process rare-earth peak

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Rapid neutron capture (the r-process) produces nearly half of the nuclei heavier than iron in explosive stellar scenarios. Above the mass number $A = 100$, there are two main peaks in the r-process solar-system abundances, are located at $A \sim 130$ and $A \sim 195$. Located between them, the Rare-Earth Peak (REP) is a tiny but definite peak at mass number $A \sim 160$ that results from the freeze-out during the last stages of neutron exposure. According to theoretical models and sensitivity studies, half-lives ($T_{1/2}$) and β-delayed neutron emission probabilities (P_{xn}) of neutron-rich nucleus, in the mass region $A \sim 160$ for $55 \leq Z \leq 64$ are critical for the formation of the REP.[1,2] As a part of the BRIKEN collaboration, the NP1612-RIBF148 experiment measured half-lives and β-delayed from Ba to Gd ($Z = 56$–64). In 2018, an experimental run centered on ^{165}Pm was conducted using a total of 5 days of beamtime. The results for Pm to Gd ($Z = 61$–64) species are already published.[3] The data analysis for Ba to Nd ($Z = 56$–60) species using the method proposed in[4] is presented in this report.

The NP1612-RIBF148 experimental setup consisted of the Advanced Implantation Detector Array (AIDA)[5] and the BRIKEN neutron counter.[6] The neutron counter was placed surrounding AIDA to detect the β-delayed neutrons offering a nominal value for the efficiency of 68.6% up to 1 MeV.

In Fig. 1, the preliminary results for the P_{1n} values are compared with evaluated nuclear data from the ENSDF and some theoretical predictions.[7–9] Preliminary reports include 14 new P_{1n} values ($^{151-152}$Ba, $^{151-153}$La, $^{154-156}$Ce, $^{155-158}$Pr, and $^{159-160}$Nd). Two other P_{1n} values ($^{149-150}$La) were also remeasured, obtaining consistent results with previous measurements. Our data supports the overall trend for all P_{1n} predictions when compared to theoretical models. The pn-RQRPA + HFM model[9] best replicates the experimental data and provides good agreement for the majority of the isotopes.

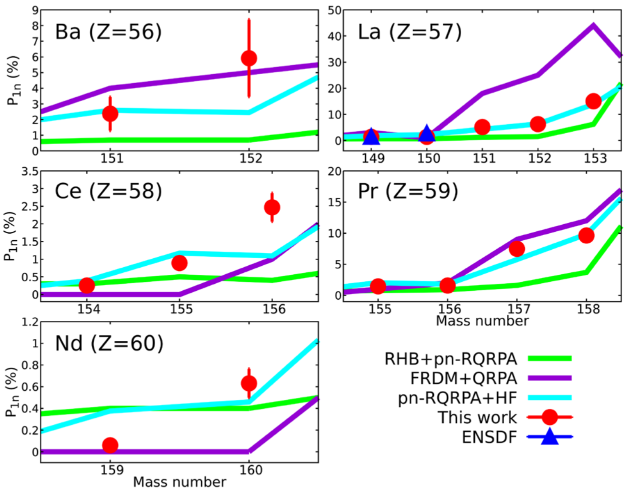

Fig. 1. Preliminary P_{1n} values derived in this work (red dot) compared with previous measurements (blue triangle) and theoretical calculations.[7–9]

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