Experimental Study of Photoactivation in Proton-Enriched ^{112}Sn and ^{113}In Nuclei and Their Role in Stellar Nucleosynthesis

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Most medium- and heavy-mass isotopes are synthesized via stellar *r*- and *s*-process neutron captures [1]. However, these mechanisms cannot account for 35 proton-rich isotopes (p-nuclei), including ^{112}Sn and ^{113}In, whose formation is dominated by low-energy photodisintegration reactions such as (γ,n), (γ,p), and (γ,α). Accurately modeling *p*-nuclei abundances requires comprehensive reaction rate datasets derived from precise experimental cross-sections.

We present experimental cross-sections for the ^{113}In(γ,n)^{112m,g}In, ^{112}Sn(γ,n)^{111}Sn, and ^{112}Sn(γ,p)^{111m,g}In reactions from their respective thresholds up to 15 MeV. The activation method coupled with high-resolution γ-ray spectrometry was employed using bremsstrahlung γ-quanta from the LINAC at the National Scientific Center "Kharkiv Institute of Physics and Technology". The results are compared with the literature data and the statistical model calculations performed via the NON-SMOKER [2] and TALYS [3] codes, considering various nuclear level densities and radiative strength functions.

A systematic analysis of γ-decay spectra at different cooling times allowed the determination of updated branching coefficients for the nine strongest transitions of ^{111}Sn. These values deviate significantly from currently adopted database benchmarks, yielding an average weighted discrepancy factor of 1.38 (±0.08). A similar discrepancy was observed for ^{113}In. These findings indicate a critical need to revise prior experimental cross-sections where ^{111}Sn and ^{113}In are residual products.

Currently, reconciling these systematic experimental deviations with standard statistical models presents a major challenge. This work aims to present these precise experimental discrepancies to stimulate advanced theoretical developments and alternative modeling of radiative strength functions. Resolving this experimental-theoretical bottleneck is essential for refining current models of the stellar *p*-process and understanding cosmic nucleosynthesis.

References

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