β-decay of ^{133}In: a bridge between nuclear structure and astrophysics

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The β-decay study of indium-133 provides a unique connection between nuclear structure and astrophysics. On one hand, ^{133}In is a perfect β-decay demonstrator of r-process nuclei in the vicinity of N=82 owing to its extreme neutron-proton asymmetry and thus large Q_{β} and $Q_{\beta n}$ windows. On the other hand, its decay daughter, ^{133}Sn, features a simple nuclear structure in its ground and excited states due to the proximity to the doubly magic ^{132}Sn. Thus, a detailed experimental measurement on the β-strength function of ^{133}In allows us to unravel the complexities of the decay process in exotic nuclei which are anchored to fundamental elements such as single-particle transitions, and to benchmark the state-of-the-art nuclear models far from the stability with the minimum complexity and ambiguity. This is a crucial step to benchmark nuclear models, predicting the properties of more exotic r-process nuclei that cannot be accessed yet experimentally.

An experimental work has been recently conducted at the ISOLDE decay station (IDS), to study the beta decays of ^{133}In. Uniquely to r-process nuclei, their beta decay involves neutrons and protons in different major shells of opposite parity, dividing the decay strength between forbidden, at low energies, and Gamow-Teller (GT) transitions, mostly unbound states [1]. The new neutron time-of-flight array, INDIe [2-4], was installed at IDS to measure the neutrons emitted from unbound states in ^{133}Sn following the beta decay of ^{133}In. Several strong transitions were observed below Ex=6 MeV, including the previously observed state at Ex=3.56 MeV [5-7]. This observation allows us to quantify with high precision the strength distribution of the GT and FF transitions in the region to the southeast of ^{132}Sn. In addition, we were able to map decay strength up to about 10 MeV excitation energy in ^{133}Sn, which is crucial to quantify multi-neutron emission probabilities in this region. In this contribution, I will present our latest results regarding the excitation energies, branching ratios, and log-ft of a series of neutron unbound states observed in the decay of ^{133}In. Our experimental findings were compared to the theoretical predictions. We carried out large-scale shell-model calculations involving several different effective nucleon-nucleon potentials, such as N3LO [6] and V_{MU} [7]. The results of these calculations and comparisons with experimental data will also be discussed.

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