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Beta decay and isomeric studies of proton-rich nuclei near the endpoint of the rp-process

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Neutron-deficient nuclei in the vicinity of the N = Z = 50 doubly-magic shell closure were produced at the National Superconducting Cyclotron Laboratory to study their structure and their relevance in the astrophysical rp-process. The 100Sn nucleus is the heaviest particle-stable N = Z nucleus, and it is also thought to be doubly magic. Additionally, 100Sn and its closest neighbours lie in the path of rp-process, therefore, the production and study of the decay properties of these nuclei are of great interest for the experimental and theoretical nuclear physics and astrophysics community.

Previous attempts to produce these nuclei were hampered by large amounts of contaminants produced with higher abundances than those of the nuclides of interest. The Radio Frequency Fragment Separator was designed and built at the NSCL in order to purify rare neutron-deficient secondary beams. The implementation of this device has made a number of β-decay experiments feasible at the NSCL, including the present work.

The nuclei of interest were produced at NSCL via fragmentation of a 112Sn primary beam accelerated to 120 MeV/nucleon, impinging on a 9Be target. The secondary beam was first selected by the A1900 Fragment Separator and purified further with the RFFS. The N = Z nuclei 100Sn, 98In and 96Cd were produced and their β decay was studied.

The experimental determination of the half-life of 96Cd was of special interest as it was the last rp-process waiting point to be measured. The effect of the half-life of 96Cd on the nuclear abundances produced by an rp-process and the origin of the light-p nucleus 96Ru was explored. Other exotic nuclei produced include 102 – 101Sn, 100, 99In, 98, 97Cd, 96 – 94Ag, 94 – 92Pd, 92, 91Rh and 90, 91Ru. Several isomeric states were found and their decay modes analysed. The experimental results will be presented and compared to shell model calculations. Also, the impact of our measurements on the astrophysical rp-process will be discussed.

Primary author: Dr BECERRIL, ANA (INSTITUTO DE ESTRUCTURA DE LA MATERIA CSIC)

Presenter: Dr BECERRIL, ANA (INSTITUTO DE ESTRUCTURA DE LA MATERIA CSIC)

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