Contribution ID: **128** Type: **Oral**

Beta-delayed neutron emission near ^{54}Ca

Thursday, 16 June 2022 10:10 (20 minutes)

Beta-delayed neutron emission (β-n) plays a vital role in shaping the elemental abundance distribution in the r-process via modifying the decay path back to stability and by contributing significantly to the neutron flux after freeze-out [1]. Modeling the β-n process requires a good model of the beta-strength functions and of the neutron emission mechanism. Statistical neutron-emission models assume gamma and neutron decay from a compound nucleus following beta decay and have successfully predicted gross properties of β-n probabilities (P_{1n}, P_{2n}, etc) in some medium- and heavy-mass nuclei. However, recent experimental work found evidence of non-statistical neutron emission after the beta decay in the vicinity of doubly magic ^{132}Sn [2]. Therefore, it is of great importance to study β-n spectroscopy in a broader area of the nuclear chart to provide stringent experimental constraints to the theories, which in astrophysical applications predict those properties for many more r-process nuclei currently out of experimental reach.

We expanded our study onto the nuclei near ^{54}Ca, which is thought to be doubly magic. An experiment studying β-n spectroscopy of ^{52,53}K was carried out at the ISOLDE Decay Station (IDS). These isotopes have large Q$_\beta$ values (energy window for β decay) and low neutron-separation energies in their daughters (^{52,53}Ca respectively), making them ideal for the studies of the β-n process. In coincidence with the beta decay of ^{52,53}K, gamma-ray and neutron-time-of-flight (TOF) spectra were measured using HPGe clover detectors and VANDLE [3]. In this contribution, I will present the latest results from the experiment, including the reconstructed excitation energies (Ex) and apparent beta feeding (I$_\beta$) of the neutron unbound states in ^{52,53}Ca, together with their exclusive neutron-emission branching ratios to the states in ^{51,52}Ca, respectively. The experimental findings were compared with the shell-model calculations and Hauser-Feshbach statistical model. These comparisons provide valuable insights into the β-n process and its
connection with the nuclear structure far from the stability line.

[1] R. Yokoyama et al, Phys. Rev. C 100, 031302(R) (2019).

[2] J. Heideman et al, being reviewed by Phys. Rev. Lett.

[3] M. Madurga et al, Phys. Rev. Lett 117, 092502 (2016).

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Session Classification: NS2022 Plenary

Track Classification: Oral Presentations