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β-delayed neutron emission studies –How storage rings can provide a complimentary measurement technique

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β-delayed neutron emission probabilities of exotic nuclei, along with nuclear masses and β-decay half-lives, are of key importance in the stellar nucleosynthesis of heavy elements via the rapid neutron-capture process (r-process). β-delayed neutron emission influences the final r-process abundance curve through the redistribution of material as neutron-rich nuclei decay towards stability, and by acting as a source of late-time neutrons which can be recaptured during the freeze-out phase. Obtaining a more complete description of this process is vital to developing a deeper understanding observed elemental abundances.
New generations of radioactive beam facilities, with state-of-the-art detector systems, will reach previously inaccessible neutron-rich nuclei for which delayed neutron-emission becomes the dominant decay process. In parallel, cutting edge nuclear models are constantly advancing and the need for accurate nuclear data only grows.
Traditional measurement techniques have relied on the correlated detection of the parent ion and its subsequent decay products, including the neutron. Due to their neutral charge, neutrons are intrinsically difficult to measure. Low detection efficiency imposes a severe loss of statistics in all experiments, thus requiring either higher beam rates, larger detectors or longer beam times. Each of these solutions presents difficulties of their own. However, storage rings can provide a complimentary technique that allows the measurement of key nuclear properties without requiring the detection of the emitted neutron. The ILIMA program at FAIR will use heavy ion detectors, such as the CsISiPHOS detector[1], installed in the ESR and CR to achieve this goal, among others.
Here, we investigate this technique and demonstrate how heavy-ion detection methods can provide complimentary means to study β-delayed neutron emission.
[1] M. A. Najafi et al., NIMA 836, 1-6, (2016)

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