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First measurement of a p-process reaction using a radioactive ion beam

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Approximately 30 stable nuclides on the neutron-deficient side of stability cannot be produced via the same neutron-capture driven mechanisms responsible for synthesizing all other elements heavier than iron. These “p-nuclei” are instead thought to originate from photodisintegration reactions on s- and r-process seed nuclei, which can occur in the extreme high-temperature environments of core-collapse supernovae. However, significant discrepancies exist, in some cases extending to orders of magnitude, between observed p-nuclei abundances obtained via isotopic analysis of meteorite samples, and supernovae model predictions. Improving on the available nuclear reaction data is an essential part of solving the puzzle of the p-nuclei, but experimental efforts in this regard must overcome significant technical challenges. This talk will describe the first ever measurement of a p-process reaction cross-section obtained with a radioactive ion beam. The $^{83}\text{Rb}(p,\gamma)^{84}\text{Sr}$ reaction was investigated at the TRIUMF-ISAC facility using a radioactive ^{83}Rb beam impinging on CH_2 foil targets. The recoiling reaction products were selected by m/q using the newly commissioned Electromagnetic Mass Analyser (EMMA), with γ -rays detected in-coincidence using the TIGRESS HPGe array. The high sensitivity of the combined EMMA-TIGRESS set-up allowed detection of low-lying transitions in ^{84}Sr populated by $^{83}\text{Rb}(p,\gamma)^{84}\text{Sr}$. The measured partial cross-section was then combined with statistical model calculations to obtain a total reaction cross-section that is 4x smaller than predicted, in-turn affecting the abundance of the ^{84}Sr p-nucleus predicted by massive-star models.

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