First Cross-Section Measurements of the 93Sr(α, xn) 95-96Zr Reactions: Implications for the Weak r-Process

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The origin of the heavy elements remains unclear, in particular the astrophysical sites thought to be responsible for the rapid (r) neutron-capture process are still uncertain. The 2017 LIGO detection of a neutron star merger (NSM) alongside a coincident kilonova provided the first direct evidence of NSMs producing an r-process. However, galactic chemical evolution models indicate that an additional r-process site which was more active during the early history of our galaxy is required to match observations of old metal-poor stars. These ancient stars exhibit significant star-to-star variations of the first r-process peak elemental abundances, which is difficult to explain with a single r-process site. A weak r-process occurring within the neutrino-driven wind of core-collapse supernovae or NSMs has been proposed as a mechanism to solve this problem by preferentially producing the first r-process peak elements. Under these conditions, nucleosynthesis is driven predominantly by (α, n) reactions acting on neutron-rich radioactive nuclei 3-5 neutrons away from stability. Reactions with 93Sr have been identified as crucial for ascertaining the final abundances of weak r-process signatures, however there are large uncertainties surrounding both the astrophysical conditions and the relevant nuclear reaction rates. To address the nuclear physics uncertainties, we recently performed an experimental study at TRIUMF using the EMMA, TIGRESS, and DEMAND detectors to measure the 93Sr(α, xn) 95-96Zr reactions. In this presentation, I will share our findings to date and discuss perspectives on future weak r-process reaction studies at TRIUMF.