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Masses of neutron-rich Ga isotopes for the formation of the 1st r-process abundance peak in neutron star merger

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Since the discovery of the GW170817 binary neutron star merger and the associated kilonova, it became clear that such an event can indeed produce heavy elements up to the lanthanide region and recent work has been focussed on understanding the formation of the 2nd and 3rd r-process abundance peaks as well as the lanthanide region. However nuclear data in these regions is scares. The situation is advantages for the 1st abundance peak, which is more in reach of current radioactive beam (RIB) facilities. However beams of these neutron-rich isotopes around the closed neutron shell at N=50 suffer from strong isobaric background, making high precision measurements challenging. To overcome the strong background an isobar separator based on the Multiple-Reflection Time-Of-Flight Mass Spectrometry (MR-TOF-MS) technique has been installed at TRIUMF's Ion Trap for Atomic and Nuclear science (TITAN), similar to other ion trap on-line facilities. The MR-TOF-MS enables high precision mass measurements of very short-lived nuclides that are weakly produced.

With mass measurements of neutron-rich Ga isotopes at TITAN, we determine one of the last missing experimental properties to model the formation of the A=84 abundance maximum of the 1st r-process peak under conditions prevalent in the ejecta of the blue kilonova of the GW170817 binary neutron star merger. Performing large-scale nuclear reaction calculations with two state of the art reaction codes, we can perform a detailed investigation on how the abundance maxima at A=80 and A=84 of the 1st r-process abundance peak are formed. This indicates that binary neutron star mergers may not have the potential to be the dominant source of light r-process elements.

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