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(I) Rapid neutron capture nucleosynthesis in the multi-messenger era

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Just over 65 years ago Burbidge, Burbidge, Fowler, and Hoyle (B2FH) charted the initial roadmap for nuclear astrophysics. This seminal work recognized that explaining the origins of the heavy elements such as lead, gold, and uranium requires at least two types of neutron capture nucleosynthesis processes with each having distinct astrophysical sites. At the time of B2FH the rapid neutron capture process (r-process) showed itself to be related to explosive astrophysical events largely via the signature of exotic, neutron-rich nuclei in the Solar abundances. Fast forward to today and we have now seen heavy element formation in the act via the impact of lanthanide elements on the observed light curve from the GW170817 merger of two neutron stars. Therefore, nowadays nucleosynthesis studies have several distinct types of observational information to assimilate, presenting the opportunity to make big leaps in our understanding of r-process sites. However, this requires careful consideration of the nuclear physics uncertainties associated with the vastly uncharted territory of neutron-rich nuclei. With both experimental and theoretical efforts providing key inputs for theoretical r-process studies, in this talk I will discuss how nuclear physics campaigns will play a central role in deciphering observables of heavy element production over the next decade.

Keyword-1

r-process

Keyword-2

neutron star mergers

Keyword-3

Author: VASSH, Nicole (TRIUMF)

Presenter: VASSH, Nicole (TRIUMF)

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