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Nucleosynthesis in the ejecta of neutron star mergers and the role of nuclear masses.

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Binary neutron star mergers have been expected to synthesize r-process elements and emit radiation powered by the radioactive decay of the freshly produced isotopes, called kilonovae. Although the observation of the kilonova was the first direct evidence of the operation of the r-process nucleosynthesis at the GW170817/AT2017gfo event, no trace of individual elements has been identified except for strontium. The blue and red components of AT2017gfo have been interpreted as the signatures of multi-component ejecta in the merger dynamics. However, the exact properties of the ejecta remain largely unconstrained. These recent observations can be used as a probe for the astrophysical conditions of neutron star merger ejecta.

Nuclear physics quantities play a crucial role in the r-process modeling. Several key parameters such as nuclear masses, β-decay half-lives, β-delayed neutron emission, fission yields, and neutron-capture rates are needed to model the r-process. While these quantities are experimentally known in the proximity of the stability line, as we move away toward the neutron drip line experimental information becomes sparse. The unavailability of experimental nuclear data dictates the use of theoretical models, which can largely differ in their predictions of nuclear properties. Sensitivity studies can provide a comprehensive framework to identify the most crucial nuclear quantities needed for the r-process.

The kilonova lightcurve and the solar r-process abundance pattern remain the only available datasets to evaluate nucleosynthesis studies and the impact of new experimental data. We performed nucleosynthesis calculations for a wide range of electron fractions, entropy, and expansion time scale conditions as well as for different nuclear physics inputs. We will present our findings concerning the sensitivity of final r-process abundances on nuclear masses. We will stress the importance of high precision mass measurements and highlight the impact of recent mass measurements from the IGISOL group.

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