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Explosive nucleosynthesis of heavy elements: an astrophysical and nuclear physics challenge

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Half of the elements heavier than iron are produced by the r process under extreme conditions. To identify its site remains one of the major challenges in nuclear astrophysics. Advances in the description of neutrino-matter interactions and its implementation in core-collapse super- nova modelling have lead to the conclusion that supernova explosions only contribute to the production of elements with Z < 50. Compact binary mergers are currently considered the best candidate for the main r-process site. These events are expected to produce gravitational waves, likely to be observed by the LIGO collaboration, and eject large amounts of neutron-rich mate- rial where the r process operates. In this talk, I will discuss the important role of nuclear physics to determine the r-process yields from compact binary mergers. In addition to neutron captures and beta decay, fission rates and yields of superheavy neutron-rich nuclei are fundamental to un- derstand the r-process dynamics and nucleosynthesis. Mergers constitute also ideal candidates to directly observe the r-process via an electromagnetic transient due to the radioactive decay of r-process material. This type of event, known as kilonova, may have already been observed associated with the gamma-ray burst GRB 130603B.

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