The beta-Oslo method: experimentally constrained (n, γ) reaction rates relevant to the r-process

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All elements found in our Universe, except for the very lightest ones, have been created during stars' lives and/or deaths. Burbidge, Burbidge, Fowler and Hoyle [1] pointed out the slow neutron-capture (s-) and the rapid neutron-capture (r-) process to be the main contributors for producing elements from iron to uranium.

On August 17, 2017, the LIGO and Virgo gravitational-wave detectors measured, for the first time, a direct signal from two colliding neutron stars [2]. Follow-up measurements with telescopes sensitive to electromagnetic radiation confirmed that the r-process had indeed taken place in the collision (*e.g.*, Ref. [3]). Hence, a long-standing question in nuclear astrophysics was solved; at least one astrophysical r-process site is now identified.

However, the uncertain nuclear-physics input remains a huge obstacle in modeling the r-process yields in large-scale nucleosynthesis network calculations [4]. The r-process inevitably involves highly neutron-rich nuclei, where there is a severe lack of relevant nuclear data such as masses, β-decay rates and neutron-capture cross sections. Well away from the valley of stability, different theoretical predictions for neutron-capture rates may vary with several orders of magnitude.

In this talk, a recently developed method to address this issue is presented: the *beta-Oslo method* [5, 6] provides data on the nuclear level density and average γ-decay strength of moderately neutron-rich nuclei. These quantities are crucial input for calculations of neutron-capture rates, which in turn play a key role in a "cold" r-process scenario [4]. The beta-Oslo method presents a first step towards constraining neutron-capture rates of importance to the r-process.

References

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