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Statistical framework for nuclear parameter uncertainties in nucleosynthesis modeling of r- and i-process

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Propagating nuclear uncertainties to nucleosynthesis simulations is key to understand the impact of theoretical uncertainties on the predictions, especially for processes far from the stability region, where nuclear properties are scarcely known. While systematic (model) uncertainties have been thoroughly studied, the statistical (parameter) ones have been more rarely explored, as constraining them is more challenging.

We present here a methodology to determine coherently parameter uncertainties by anchoring the theoretical uncertainties to the experimentally known nuclear properties through the use of the Backward Forward Monte Carlo method. We use this methodology for two nucleosynthesis processes: the intermediate neutron capture process (i-process) and the rapid neutron capture process (r-process). We determine coherently for the i-process the uncertainties from the (n,γ) rates while we explore the impact of nuclear mass uncertainties for the r-process.

The effect of parameter uncertainties on the final nucleosynthesis is in the same order as model uncertainties, suggesting the crucial need for more experimental constraints on key nuclei of interest. We show how key nuclear properties, such as relevant (n,γ) rates impacting the i-process tracers, could enhance tremendously the prediction of stellar evolution models by experimentally constraining them.

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