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Nuclear physics uncertainties in nucleosynthesis of s- and p-nuclei

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Even in nucleosynthesis processes involving nuclei at or close to stability, not all reaction rates are experimentally constrained. In addition, even with the presence of measurements, these are often not able to fully constrain the stellar reaction rate due to thermal population of excited target states in the stellar plasma or bear large error bars. From a theory point of view, certain nuclear properties, such as gamma-strength functions or optical potentials, have to be predicted. These problems introduce sometimes considerable uncertainties in the predicted yields, in addition to uncertainties stemming from the astrophysical modelling. A short overview of the currently prevailing nuclear uncertainties and attempts for future improvements in the framework of the compound and direct reaction mechanisms is given. To guide future improvements in measurements and theoretical models it is necessary to quantify the total uncertainties introduced in the final isotopic yields by the conspiration of all combined individual uncertainties and to identify the reaction mostly contributing to a given uncertainty. A versatile Monte Carlo tool has been developed to address this question. It allows the simultaneous variation of thousands of reaction rates within their individually assigned error bars. This tool is being applied to study a number of nucleosynthesis scenarios and to quantify the nuclear uncertainties appearing within them. As examples, results are presented for the gamma-process and the weak s-process in massive stars and the main s-process in intermediate mass stars. Elemental and isotopic uncertainties are shown and key reactions identified.

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