A LARGE SCALE MONTE CARLO STUDY OF NUCLEOSYNTHESIS BASED ON NUCLEAR PHYSICS UNCERTAINTIES

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We have been developing a framework for studying uncertainty of nuclear reactions using a Monte Carlo method with general nuclear reaction networks. The scheme aims to perform large scale Monte Carlo simulations of networks including more than 5000 isotopes with dozens of thousands reactions, which are feasible using high-performance computing systems. This method bridges nuclear physics and astronomical observations by determining the impact of nuclear uncertainties on nucleosynthesis predictions quantitatively.
In this presentation, after presenting the concept and numerical method of our Monte Carlo approach, we will show first results focusing on the weak-s and p processes taking place in massive stars. The weak s-process takes place in stellar core-He and shell-C burning during evolution and p-process in the O/Ne layer of core-collapse supernova, respectively. These nucleosynthesis processes are closely related and may be constrained using solar abundances. The dominant nuclear reactions are neutron capture reaction and beta decays and several gamma-reactions (photo-disintegration) around stable isotopes heavier than iron. We examine impacts on nucleosynthesis for each reaction type distinguishing theoretically and experimentally determined rates. Our results will determine which rates are most uncertain and which precision is needed in future experiments in order to reduce the uncertainty in nucleosynthesis predictions.