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# BARONET: A Lightweight Nuclear Network Geared Towards Coupling with Hydrodynamic Simulations

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Accounting for out-of-NSE (nuclear statistical equilibrium) r-process nucleosynthesis is one of the most sought-after goals in the (numerical) modelling of binary neutron star (BNS) mergers. While post-processing analysis via full nuclear networks is a reliable technique, the computational and storage costs prevent such calculations to be directly coupled to hydrodynamic codes, thus neglecting the dynamical influence of the r-process heating.
We present a novel framework, orthogonal to reduced networks, based on a careful selection and combination of the dominant degrees of freedom of nucleosynthesis and exploiting the “beta-flow” approximation, that drastically reduces the computational and storage requirements w.r.t. a full network while returning accurate predictions for both isotope abundances and heating rate. This technique features:
1) far less degrees of freedom than a full network (~300 vs. 8000);
2) explicit split between dominant/subdominant and fast/slow reactions;
3) ability to accurately track the time evolution of abundances and heating rate.
We summarize its base assumptions and derivation, practical implementation issues, and its application to parametrized BNS ejecta along with a detailed comparison w.r.t. to full networks such as SkyNet and WinNet. Finally, we show the first results of BNS merger simulations with inline nucleosynthesis performed with this model.

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