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Nuclear Data Needs for Dynamic Nucleosynthesis in Stars

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Recent advances in 3D hydrodynamic simulations of stellar interiors and multi-zone nucleosynthesis calculations have identified specific nuclear reaction rates on unstable species whose experimental determination would significantly reduce uncertainties in predicted abundances and allow probing the 3D macro physics entangled with dynamic nucleosynthesis. In the intermediate neutron-capture process, which operates at neutron densities of 10^13 to 10^16 cm^-3, Monte Carlo sensitivity studies identify (n,gamma) reactions on unstable isotopes, particularly 88Kr, 88,89Rb, 90,92Sr, 139Ba, and 141La, as critical for reproducing observed first-peak element abundances in CEMP-i stars. Improved constraints on 141Ba and 141La capture rates are especially needed, as uncertainties in these rates drive a persistent discrepancy in the predicted Pr abundance for metal poor stars like CS 31062-050. New studies of O-C shell mergers in massive star progenitors, where 3D simulation-inspired mixing was explored with nucleosynthesis post-processing, that 100Pd(gamma,p) and (gamma,alpha) correlate with the production of p-process isotopes 92Mo, 96,98Ru, and 102Pd, while 40Ca(n,p) and 39Ar(p,gamma) govern 40K production and 43Ca(p,gamma) and 44Sc(p,n) govern 44Ti yields across all mixing scenarios.

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