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Numerical simulations of dynamic i-process nucleosynthesis in stars constrained by nuclear physics experiments and astrophysical observations

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We present evidence that the heavy-element abundances in maybe most carbon-enhanced metal-poor stars point to i-process nucleosynthesis, at neutron densities intermediate between those of the s- and r-processes. The i process may occur in a helium convective zone that entrains hydrogen from an adjacent H-rich envelope, for example in rapidly-accreting white dwarfs, like those considered to lead to Supernova Ia explosions in the single-degenerate channel, in asymptotic giant branch (AGB) stars at low metallicities, in super-AGB stars or possibly Pop III massive stars. Our i-process nucleosynthesis simulations of multi-zone models of RAWDs and AGB stars are compared with elemental and isotopic abundance ratios measured in CEMP stars and pre-solar dust grains. The i-process path proceeds through unstable species, which have mostly only theoretical neutron-capture reaction rates from Hauser-Feshbach models. Early experimental results have already reduced the uncertainty of key (n,g) cross sections. Based on our Monte Carlo (MC) simulations, in which all rates are varied within their limits estimated from Hauser-Feshbach computations we obtained updated results on the most important future measurements. We show that in addition to accurate nuclear physics data time-dependent hydrodynamic effects of convective-reactive i-process nucleosynthesis are key to reconcile observations with model predictions.

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