UNDERSTANDING THE SENSITIVITY OF CORE-COLLAPSE SUPERNOVAE SIMULATIONS TO WEAK INTERACTION RATES

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In the past decade the treatment of electroweak interactions in core-collapse supernovae (CCSNe) simulations has improved significantly. As an example, we now understand the critical role electron capture plays in destabilizing the stellar core to collapse and its impact on the whole thermodynamic composition/configuration during the in-fall epoch. Electron capture rates are therefore crucial nuclear physics inputs to CCSNe simulations. These rates are estimated on the basis of theoretical nuclear structure calculations which are evaluated against results from beta-decay and charge-exchange (CE) experiments
[1]. Intermediate energy (+100 MeV/u) CE reactions in the β+ direction, with (n,p), (d,2He), (t,3He) and similar probes, connect the same initial and final states as electron capture, and are therefore keenly poised to study the underlying nuclear transitions and at the same time provide a rigorous test of electron-capture rates derived from theory. By implementing detailed weak interaction rates into neutrino transport calculations utilized by the CCSNe code GR1D, we are now able to test in great detail the sensitivity of the evolution of supernovae to electron-capture rates. This effort will help identify which experiments (including those in the future at FRIB) are most important for improving nuclear theory and, by extension, the astrophysical models

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