A simple parameterization of the consequences of deleptonization for simulations of stellar core collapse

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A simple and computationally efficient parameterization of the deleptonization, the entropy changes, and the neutrino stress is presented for numerical simulations of stellar core collapse. The parameterization of the neutrino physics is based on a bounce profile of the electron fraction as it results from state-of-the-art collapse simulations with multigroup Boltzmann neutrino transport in spherical symmetry. Two additional parameters include an average neutrino escape energy and a neutrino trapping density. The parameterized simulations reproduce the consequences of the delicate neutrino thermalization-diffusion process during the collapse phase and provide a by far more realistic alternative to the adiabatic approximation, which has often been used in the investigation of the emission of gravitational waves, of multidimensional general relativistic effects, of the evolution of magnetic fields, or even of the nucleosynthesis in simulations of core collapse and bounce. For supernova codes that are specifically designed for the postbounce phase, the parameterization builds a convenient bridge between the point where the applicability of a stellar evolution code ends and the point where the postbounce evolution begins.

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