PARAMETRIZED SPHERICALLY SYMMETRIC CORE COLLAPSE SUPERNOVA SIMULATIONS: PUSH

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Core-collapse supernovae occur at the end of the life of massive stars $(\mathrm{M} \gtrsim 8-10\mathrm{M}_{\odot})$. Despite many decades of supernova simulations, the detailed explosion mechanism is not yet fully understood. While multi-dimensional models are needed for an accurate study of the explosion mechanism, they are currently computationally too expensive for systematic studies for large numbers of progenitor models. Though a suitable method to study large numbers of stellar progenitors, simulations in spherical symmetry with detailed neutrino transport and general relativistic gravity fail to explode self-consistently except for the lowest-mass core-collapse progenitors. We report on a new method, PUSH, for triggering core collapse supernova explosions of massive stars in spherical symmetry. This method provides a framework to study many important aspects of core-collapse supernovae: the effects of the shock passage through the star, explosive supernova nucleosynthesis, the progenitor-remnant connection, and other aspects of core-collapse supernovae where traditional piston or thermal bomb models do not capture the relevant physics. To trigger explosions in the otherwise non-exploding simulations, we rely on the neutrino-driven mechanism. The PUSH method taps the energy reservoir provided by the heavy neutrino flavours to locally increase the energy absorption in the gain region. The simulations were performed making use of the general relativistic hydrodynamics code Agile[1]. For the high-density plasma the tabulated microphysical equation of state of Hempel et al.[2] with the DD2 parametrization for the nucleon interactions have been used. We employ the Isotropic Diffusion Source Approximation[3] for the electron flavour and an advanced energy-dependent leakage scheme[4] for the heavy-lepton flavour neutrino transport. We will show that our method reproduces the known properties of SN 1987A[5,6]. In a second step, the calibration to SN1987A is used to investigate a series of progenitor models with mass between $18M_{\odot}$ and $21M_{\odot}$. We focus on $\mathrm{E}_{\mathrm{exp}}$, M_{Ni}, $\mathrm{t}_{\mathrm{exp}}$, and $\mathrm{M}_{\mathrm{remnant}}$, show trends as a function of progenitor compactness, and investigate the differences in the supernova outcome.

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