N06a   Comparing Explodability Predictions from a Parameter-Optimized Semi-Analytic Model with Structure-Based Progenitor Criteria

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Three-dimensional (3D) simulations of neutrino-driven core-collapse supernovae provide the most reliable predictions of explosion outcomes, but their high computational cost prevents systematic surveys across large progenitor sets. Using a parameter-optimized version of the Müller et al. (2016) semi-analytic one-dimensional (1D) explosion model, recently calibrated against the 3D results of Burrows et al. (2024), we investigate how effectively a fast 1D framework can capture progenitor explodability. We compare the model's explosion predictions and remnant properties with several commonly used structure-based explodability criteria, including compactness, the free-fall mass coordinate, and the two-parameter criterion $\mu_4 - M_4$. Our analysis shows that, unlike traditional structure-based metrics, the semi-analytic model can adjust physically meaningful parameters to match the trends revealed by 3D simulations, thereby enabling direct examination of the underlying physics that governs explodability. We identify where the semi-analytic model and these structural criteria agree, where they diverge, and what physical trends account for these differences. This analysis clarifies the strengths and limitations of structure-based explodability criteria when evaluated against a parameter-optimized neutrino-driven semi-analytic model.