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Exploring Core-Collapse Supernovae with GPU Acceleration Code GAMER: Dynamics, Magnetism, Gravitational Waves

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Core-collapse supernovae (CCSNe) are among the most energetic astrophysical events and key sites for nucleosynthesis of heavy elements, and also thought be the multimessenger signal site, especially gravitational waves (GW). They are driven mainly by the neutrino explosion, but also complicate interplay of equation of state, gravity, and magnetohydrodynamics. We present results from numerical simulations of CCSNe conducted using the GPU-accelerated Adaptive-MEsh-Refinement code (GAMER). In particular, we investigate the role of rotation and magnetic fields in shaping the explosion outcome. Our study also explores the possible generation of GW signals, analyzing their characteristics and detectability. Additionally, we incorporate a numerical hybrid equation of state (EoS), combining a nuclear EoS with the Helmholtz EoS, which is crucial for modeling the long-term evolution of the supernova remnant. Tracer particles are used to track ejecta properties and nucleosynthesis pathways.

Section

High Energy

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