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3D core-collapse supernova models with phenomenological treatment of neutrino flavor instabilities

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We perform three-dimensional supernova simulations with a phenomenological treatment of neutrino flavor conversions. We show that the explosion energy can increase to as high as $\sim 10^{51}$ erg depending on the critical density for the onset of flavor conversions, due to a significant enhancement of the mean energy of electron antineutrinos. Our results confirm previous studies showing such energetic explosions, but for the first time in three-dimensional configurations. In addition, we predict neutrino and gravitational wave (GW) signals from a nearby supernova explosion aided by flavor conversions. We find that the neutrino event number decreases because of the reduced flux of heavy-lepton neutrinos. In order to detect GWs, next-generation GW telescopes such as Cosmic Explorer and Einstein Telescope are needed even if the supernova event is located at the Galactic center. These findings show that the neutrino flavor conversions can significantly change supernova dynamics and highlight the importance of further studies on the quantum kinetic equations to determine the conditions of the conversions and their asymptotic states.

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