The Role of Collective Neutrino Flavor Oscillations in Core-Collapse Supernova Shock Revival

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We explore the effects of collective neutrino flavor oscillations due to neutrino-neutrino interactions on the neutrino heating behind a stalled core-collapse supernova shock. We carry out axisymmetric (2D) radiation-hydrodynamic core-collapse supernova simulations, tracking the first 400 ms of the post-core-bounce evolution in 11.2 solar mass and 15 solar mass progenitor stars. Using inputs from these 2D simulations, we perform neutrino flavor oscillation calculations in multi-energy single-angle and multi-angle single-energy approximations. Our results show that flavor conversions do not set in until close to or outside the stalled shock, enhancing heating by not more than a few percent in the most optimistic case. Consequently, we conclude that the postbounce pre-explosion dynamics of standard core-collapse supernovae remains unaffected by neutrino oscillations. Multi-angle effects in regions of high electron density can further inhibit collective oscillations, strengthening our conclusion.

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