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Supernova neutrino flavor composition: non-adiabatic MSW evolution and shock-wave effects

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Predicting the flavor composition of supernova neutrinos is a challenging task due to the high-density conditions in the stellar interior, where neutrino self-interactions can significantly modify flavor evolution. Considering a broad range of possible post-collective neutrino flavor states, we study the range of flavor compositions that can be obtained for supernova neutrinos arriving at Earth. We numerically investigate the subsequent three-flavor MSW evolution through the stellar envelope, focusing on departures from the adiabatic approximation and on the effects of idealized time-dependent shock-wave profiles. For a given non-adiabatic evolution, we quantify how assumptions on the post-collective state constrain the final flavor composition by comparing the areas of the corresponding allowed regions in ternary plots with that obtained for a fully arbitrary initial state. We study this quantity for different neutrino energies and post-bounce times, providing a quantitative characterization of how the stellar density profile affects the flavor-composition constraints of supernova neutrinos.

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