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Decoherence in supernova neutrino transformations suppressed by deleptonization

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In the dense-neutrino region at 50–400 km above the neutrino sphere in a supernova, neutrino-neutrino interactions cause large flavor transformations. We study when the multi-angle nature of the neutrino trajectories leads to flavor decoherence between different angular modes. We consider a two-flavor mixing scenario between ν_e and another flavor ν_x and assume the usual hierarchy $F_{\nu_e} > F_{\bar{\nu}_e} > F_{\nu_x} = F_{\bar{\nu}_x}$ for the number fluxes. We define $\epsilon = (F_{\nu_e} - F_{\bar{\nu}_e})/(F_{\bar{\nu}_e} - F_{\bar{\nu}_x})$ as a measure for the deleptonization flux which is the one crucial parameter. The transition between the quasi single-angle behavior and multi-angle decoherence is abrupt as a function of ϵ. For typical choices of other parameters, multi-angle decoherence is suppressed for $\epsilon \gtrsim 0.3$, but a much smaller asymmetry suffices if the neutrino mass hierarchy is normal and the mixing angle small. The critical ϵ depends logarithmically on the neutrino luminosity. In a realistic supernova scenario, the deleptonization flux is probably enough to suppress multi-angle decoherence.

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