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Fast Flavor Ocillations of Supernova neutrinos in three flavors

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Neutrinos emitted from a core-collapse supernova (SN) may undergo fast flavor conversions almost immediately above the core, resulting in drastic consequences for the supernova explosion mechanism and nucleosynthesis. These fast flavor oscillation dynamics are independent of the neutrino mass, growing at the scale of the large neutrino-neutrino interaction strength (10^5 km^ −1) of the dense core which is extremely fast, in comparison to the usual 'slow' collective modes driven by much smaller vacuum oscillation frequencies (10^0 km^−1). The necessary condition for the existence of these fast instabilities is the presence of a zero-crossing in the angular distribution of the neutrino lepton number. The previous literature on fast conversions have focussed on an effective two-flavor analysis, where the zero crossing in electron lepton number (ELN) was crucial since the assumption of similar number density of the the heavy lepton neutrinos lead to similar angular spectra. However, motivated from the recent supernova simulations with muon production in the accretion phase, we perform the first non-linear simulations of fast conversions in the presence of all the three neutrino flavors. Our results show the significance of muon and tau lepton number angular distributions, along with the traditional electron lepton number ones and strengthen the need to further investigate the occurrence of fast conversions in supernova simulation data, including the degeneracy breaking of mu and tau neutrinos.

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