High Energy Physics - Phenomenology

Linearized flavor-stability analysis of dense neutrino streams

Arka Banerjee, Amol Dighe (Tata Inst.), Georg Raffelt (Munich, Max Planck Inst.)

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Neutrino-neutrino interactions in dense neutrino streams, like those emitted by a core-collapse supernova, can lead to self-induced neutrino flavor conversions. While this is a nonlinear phenomenon, the onset of these conversions can be examined through a standard stability analysis of the linearized equations of motion. The problem is reduced to a linear eigenvalue equation that involves the neutrino density, energy spectrum, angular distribution, and matter density. In the single-angle case, we reproduce previous results and use them to identify two generic instabilities: The system is stable above a cutoff density ("cutoff mode"), or can approach an asymptotic instability for increasing density ("saturation mode"). We analyze multi-angle effects on these generic types of instabilities and find that even the saturation mode is suppressed at large densities. For both types of modes, a given multi-angle spectrum typically is unstable when the neutrino and electron densities are comparable, but stable when the neutrino density is much smaller or much larger than the electron density. The role of an instability in the SN context depends on the available growth time and on the range of affected modes. At large matter density, most modes are off-resonance even when the system is unstable.

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