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Stimulated Neutrino Transformation With Multiple Sinusoidal Potentials

KELLY PATTON, North Carolina State Univ

Neutrinos have been known to oscillate between their flavors as they propagate for almost two decades, but a detailed understanding of their oscillation behavior in complex astrophysical environments, such as core collapse supernovae, is a subject of ongoing investigation. We study one aspect of such an environment - what happens when the matter density that the neutrinos travel through is not smooth, or is even turbulent? We consider the effect of density fluctuations on neutrino flavor transformation and find some startling results. By decomposing the matter density into a Fourier series, we find that two different ranges of frequencies contribute to the evolution. The first are those terms with frequencies corresponding to the energy splitting between the neutrino states or an integer fraction of that splitting, a phenomenon known as parametric resonance. Additionally, we show analytically that the long wavelength modes also significantly affect the results. We find that we can successfully predict the amplitudes and wavelengths of the resulting oscillations between the neutrino states for matter density profiles which consist of up to fifty Fourier modes.

In collaboration with James Kneller and Gail McLaughlin, North Carolina State University.