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Energy Dependence of Angular-Driven Flavor Instabilities in Dense Astrophysical Environments

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In core-collapse supernovae and neutron star mergers, the neutrino density is so large that neutrino-neutrino refraction can lead to collective flavor conversions independent of vacuum mixing. These are called fast flavor conversions since the neutrino self-interaction strength μ represents the characteristic time scale of the system. In the limit of vanishing vacuum mixing, one necessary condition for these conversions is the existence of a zero-crossing in the momentum angular distribution of neutrino FLN (Flavor Lepton Number). However, it has been empirically realized that the vacuum frequency ω can significantly affect the onset of flavor conversion even if $\mu \gg \omega$. In this work, we study more deeply the impact of ω on angular-driven flavor instabilities. Focusing on a homogeneous and axially symmetric neutrino gas, we show that a non-zero vacuum frequency is responsible for inducing flavor instabilities with a non-negligible growth rate in a neutrino gas that would be stable for $\omega = 0$, despite the presence of a FLN angular zero-crossing. Relying on a perturbative approach, we establish a connection between odd powers of ω and the neutrino FPN (Flavor Particle Number) angular distribution, showing that flavor conversion dynamics under $\omega \neq 0$ are influenced by both FLN and FPN. We also explore the possibility of mapping the system with $\omega \neq 0$ to an effective one with $\omega = 0$.

Poster prize

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