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Neutrino Oscillation in Dense Matter

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As the increasing of neutrino energy or matter density, the neutrino oscillation in matter may undergo "vacuum-dominated", "resonance" and "matter-dominated" three different stages successively. Neutrinos endure very different matter effects, and therefore present very different oscillation behaviors in these three different cases. In this talk, we focus on the less discussed matter-dominated case, discuss the intriguing features of the effective neutrino mass and mixing parameters as well as neutrino oscillation probabilities in dense matter. We show that as the matter potential growing larger, the effective mixing matrix in matter evolves approaching a fixed constant real matrix which is free of CP violation and can be described using only one simple mixing angle. As for the neutrino oscillation behavior, electron neutrinos decoupled in the matter-dominated case due to its intense charged-current interaction with electrons while a two-flavor oscillation are still presented between the muon neutrinos and tau neutrinos.
After these general discussion, we make a very bold comparison of the oscillation behaviors between neutrinos passing through the Earth and passing through a typical white dwarf and show that when neutrinos passing through a compact object like white dwarf, its energy spectrum would be distorted due to the intense matter effect. We call this interesting result the "neutrino lensing" effect. And different from the gravitational lensing effect which is capable of uncovering the mass distribution in our universe, this "neutrino lensing" effect could be sensitive to the distribution of electrons (or positrons) in the space through their weak interactions with neutrinos.
This talk is based on an recently published paper of us with the same title.(https://doi.org/10.1103/PhysRevD.101.033005)

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