Title:	Neutrino oscillations in curved space-time: Implications for neutrino physics
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Abstract:	It is now established that neutrinos are massive particles and can oscillate between their flavors. However, from oscillation experiments, we only know the differences in the squared masses of neutrinos, whereas the absolute masses of neutrinos are still unknown. This is because, in the flat spacetime, neutrino oscillation is known to be only sensitive to the differences in the squared masses of neutrinos and not to the ab- solute masses of neutrinos. In this thesis, we study neutrino oscillations in curved spacetime to find methods by which one can shed light on the absolute masses of neutrinos. Unlike in flat spacetime, in curved spacetime, there exist conditions where coherently produced neutrinos can take multiple paths to reach the detector. The dif- ference in the accumulated phases of neutrinos arriving at the detector from different paths now depends on the absolute masses of neutrinos. This is because the phase accumulated by the neutrino along a path is proportional to its mass and the proper time elapsed during its trajectory. Therefore, the change in the phase is different along the different paths even for the same species of massive neutrino, thus creating a non- zero path difference in the neutrino phase and, consequently, for the other combina- tions of neutrino phases for the different massive species of neutrinos. Using the plane wave approximation of neutrino wavefunction, we show that the gravitational lensing of neutrinos modifies the standard picture of neutrino oscillations, where the oscilla- tion probabilities only depend on the differences in the squared masses of neutrinos. Now, oscillation probabilities depend on the absolute masses of neutrinos and their ordering, and the absolute masses of neutrinos can be inferred from the oscillations profile. Further, we incorporate wave packet formalism in our study, as in a realis- tic scenario, neutrinos are produced as a wavepacket and get detected by a localized detector. The wavepacket formalism brings in a new phenomenon in neutrino oscilla- tions known as neutrino decoherence (after which neutrinos stop oscillating into their flavors). We find that even after the decoherence, the phenomenological estimation of decoherence length can also provide vital information about the absolute masses of neutrinos as the decoherence length depends on the absolute masses of neutrinos. iABSTRACT After that, we include rotation to a gravitating body to see the deviation in the results of neutrino lensing and neutrino propagation due to the rotation of the gravitational body from the non-rotating case of Schwarzschild spacetime. The deviation in the os- cillation probability profile due to the rotation of the gravitational source is significant for one-sided neutrino propagation. In contrast, for the gravitationally lensed neutri- nos, the rotation of gravitational sources becomes prominent for the massive gravita- tional sources like supermassive black holes and galaxy structures. Thus, one should appropriately consider gravitational effects in neutrino oscillations for a comprehen- sive understanding of neutrino flux arriving on the earth from astrophysical sources of neutrinos. Moreover, studying them can also provide vital information regarding various physical problems.
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