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$\tau-$lepton polarization in the charged current $\nu_\tau - N$ and $\nu_\tau - A$ DIS processes

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The study of tauon(τ-lepton) is one of the topics of current interest as its understanding is required for various important aspects such as to test the lepton flavor universality, for the accurate measurement of the neutrino oscillation parameters, to reduce the uncertainties in the ν_l-nucleus cross section measurements, etc. Since the tauon has higher threshold and very short lifetime ($\simeq 2.9 \times 10^{-13}$ sec), therefore, it is very difficult to observe. Till date a few tauon events with limited statistics have been observed in the accelerator and atmospheric neutrino experiments such as DONuT, NOMAD, OPERA, SuperK and IceCube.

The experimenters have planned
to study the tauon production with higher statistics via the decay of
D_s-meson ($D_s \rightarrow \tau\nu_\tau$) in the DsTau and SHiP experiments as well as through the $\nu_\mu \rightarrow \nu_\tau$ oscillation channel
in the DUNE and T2HK experiments, which covers a wide energy spectrum of neutrinos. For example, at DUNE it is expected that ν_τ
events in the appearance mode would be between 100 to 1000. The τ-leptons are identified by the observation of leptons and pions whose decay rates and the topologies depend upon the production cross section and polarization of the τ-leptons produced through the various reaction processes such as quasielastic, inelastic and deep inelastic scattering in the ν_τ-nucleon interactions. In the low and intermediate energy regions ($\approx$ few GeV) the tauon is not fully polarized while at very high energies i.e., $E_{\nu_\tau} >> m_\tau$,
it is fully polarized. In the literature there are several studies for the τ polarization in the quasielastic and inelastic
reaction channels but for deep inelastic scattering (DIS) process studies are very limited.

We have studied the tauon polarization for the charged current induced DIS process in the case of free nucleon as well as in the nuclear targets which are being used in the ongoing and proposed experiments. In the standard model the transverse component of lepton polarization
is zero due to time reversal invariance. We shall present the results for the longitudinal and perpendicular components of the tau polarization both for the ν_τ scattering from the free nucleon as well as off the nuclear targets, where the effect of nuclear medium modification by taking into account Fermi motion, binding energy, nucleon correlations, mesonic contribution and shadowing effects have been considered.

Session

Neutrino Physics

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