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Astrophysical Tau Neutrino Searches with Hyper-Kamiokande

Tau neutrinos are among the least studied particles in the Standard Model due to the challenges in producing and detecting them. One of the primary sources of tau neutrinos is astrophysical events, where they are mainly produced through flavor oscillations. This flux has been detected by neutrino telescopes like IceCube, but identifying the tau component of the flux —especially at TeV-scale energies —is difficult due to the short lifetime of the tau lepton and its similarity to electron neutrinos or neutral current interactions. In this work, we explore the potential of water Cherenkov experiments like Super-Kamiokande and its next-generation upgrade, Hyper-Kamiokande, to measure the astrophysical neutrino flux and isolate the tau component. Such measurements would be essential not only as the first low-energy detection of the astrophysical neutrino flux but also as a critical tool to probe Beyond the Standard Model (BSM) scenarios involving tau neutrinos, such as those linked to dark matter interactions.

Collaboration(s)

Author: RAMOS CASCON, Elena (Donostia International Physics Center (DIPC) (ES))

Presenter: RAMOS CASCON, Elena (Donostia International Physics Center (DIPC) (ES))

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