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Bayesian neutrino oscillation analysis with 715 kton-yr of KM3NeT/ORCA

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KM3NeT/ORCA is a water-Cherenkov neutrino telescope currently under construction in the Mediterranean Sea, aimed at measuring atmospheric neutrino oscillations and determining the neutrino mass ordering. The detector consists of a three-dimensional array of detection units, each equipped with 18 digital optical modules, which house 31 photomultiplier tubes. The Cherenkov light induced by charged particles produced in neutrino interactions is used to reconstruct the parent neutrino's direction and energy, allowing for constraints on the oscillation parameters Δm^2_{31} and θ_{23}.

This work presents the first Bayesian neutrino oscillation analysis performed with KM3NeT, using 715 kton-years of exposure from the ORCA detector. An adaptive Metropolis-Hastings algorithm is employed to construct a Markov Chain Monte Carlo, which samples the posterior probability density function (PDF) in the multidimensional space spanned by oscillation and nuisance parameters. The credible region at 90\% Confidence Level for the oscillation parameters, $\Delta m^2_{31} \in [-2.61, -1.80] \times 10^{-3}$ eV^2 assuming Inverted Ordering ($\Delta m^2_{31} \in [1.92, 2.73] \times 10^{-3}$ eV^2 for Normal Ordering) and $\sin^2\theta_{23} \in [0.37, 0.62]$, are inferred from the marginal posterior PDF in what constitutes a novel statistical approach in the field of atmospheric neutrino oscillations. Moreover, the Bayesian approach is applied to perform inference on the higher-dimensional model of Non-Standard Neutrino Interactions.

Collaboration(s)

KM3NeT Collaboration

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