

Atmospheric muon studies and light sterile neutrino search with KM3NeT/ORCA

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Abstract

The KM3NeT collaboration is currently building two Cherenkov neutrino telescopes at the bottom of the Mediterranean sea, ORCA (Oscillation Research with Cosmics in the Abyss) to measure atmospheric neutrino oscillations and ARCA (Astroparticle Research with Cosmics in the Abyss) to detect neutrinos from astrophysical sources. In this manuscript, after reviewing the status of neutrino oscillation measurements and light sterile neutrino searches in the first chapter, the KM3NeT detectors are presented in the second chapter. In chapter 3, a calibration method based on the quality of the reconstructed atmospheric muon tracks is used to cross-validate the position and orientation calibration procedures of KM3NeT detectors, and a new muon-based method is developed to perform the time calibration in a much less CPU intensive way than the previous method. Then, in chapter 4, atmospheric muons are further studied to select those stopping within the instrumented volume of KM3NeT/ORCA. We show that with a very partial configuration (5%) of the ORCA detector, more than 8000 stopping muons can be selected per day with a purity of more than 95% and an excellent agreement between data and simulations. Finally, chapter 5 describes the first oscillation analysis performed with ORCA data to search for a light sterile neutrino. No positive signal is found at a 90% confidence level, and competitive limits are put on the magnitude of the mixing of muon and tau neutrinos with a sterile state.