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Feasibility study of measuring the neutrino mass hierarchy with a deep underwater Cherenkov detector: KM3NeT - ORCA

Following the measurement of the θ13 mixing parameter, the determination of the neutrino mass hierarchy (normal: m1 < m2 < m3 or inverted: m3 < m1 < m2) has become a central goal in upcoming and next-generation neutrino physics experiments. Atmospheric neutrino experiments have emerged as a promising pathway to this measurement, through the exploitation of Earth-induced matter effects in the GeV energy range.
ORCA (Oscillation Research with Cosmics in the Abyss) is a proposal to conduct such a measurement of the neutrino mass hierarchy with atmospheric neutrinos (and possibly also with a neutrino beam) using a large underwater Cherenkov detector. It is being developed in the framework of the KM3NeT Collaboration, which aims at deploying a multi-km3 Cherenkov neutrino telescope in the Mediterranean Sea to complement and extend the reach of the IceCube detector at the South Pole.
The current status of the ORCA feasibility study will be presented, based on a reference detector of 1000 optical modules (OM) distributed on 50 lines, with typical interline spacing of 20m and inter-OM spacing of 6m, corresponding to an instrumented water mass of 1.8 Mton. The optimization of the final geometry is part of the study. The performances of the selection and reconstruction algorithms developed for track-like events (muon neutrinos) will be presented, together with the latest sensitivity estimates. Assuming a 30% (20%) Gaussian uncertainty on the neutrino energy, the sensitivity already rises to ~3.8σ (4.5σ) over 6 years for the reference detector. This could be significantly enhanced by combining with the results obtained with cascade-like events (mostly electron neutrinos). The latest achievements in this respect will be presented as well.

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Track Classification: Atmospheric Neutrinos