NuSET: Neutrino Studies and Earth tomography with the KM3NeT neutrino telescope

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Ph.D. proposed by the KM3NeT group at Laboratoire Astroparticules et Cosmologie (APC) in collaboration with Institut de Physique du Globe de Paris (IPGP)

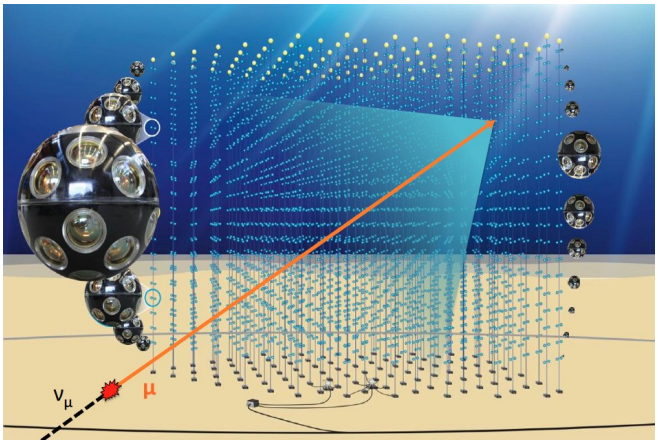
Neutrino Cherenkov telescopes consist in 3D arrays of photomultipliers (PMTs) that detect the Cherenkov light emitted by the charged particles produced when a neutrino that has traversed the Earth interacts near the detector. KM3NeT [1] is the next-generation neutrino telescope in the Northern Hemisphere, currently under construction on two abyssal sites in the Mediterranean: ARCA (near Capo Passero, Sicily) focusing on high-energy (TeV-PeV) neutrino astronomy, and ORCA (near Toulon, France) dedicated to the measurement of the neutrino mass hierarchy with atmospheric neutrinos. Several detection lines have been deployed on both sites so far, and the amount of data collected is expected to increase rapidly in the upcoming year, along with the expanding arrays, that will reach respectively 115 lines (for ORCA) and 330 lines (for ARCA).

Because of their weak interactions, neutrinos can traverse large amounts of matter, thereby offering an alternative way of probing the structure and composition of the Earth. Neutrinos produced in the interaction of cosmic rays with the atmosphere are particularly appealing for Earth tomography studies as they span a wide range of energies and pathlengths across the Earth. Two different methodological approaches can be explored with data from KM3NeT, both based on the study of the energy and angular distributions of atmospheric neutrinos that reach the detectors after traversing the Earth: oscillation and absorption tomography [2]. The main aim of the NuSET project is to evaluate and develop the potential of atmospheric neutrino tomography as an alternative method to constrain the Earth composition and matter content. Such a study will increase the physics reach of the KM3NeT experiment and provide new synergies between neutrino physics and Earth sciences. Guided by the preliminary sensitivity studies and first data analysis, the project will also pave the way to future progress in the field, studying and proposing alternative neutrino detector configurations that would be fully optimized for Earth tomography studies.

Job description

The succesfull candidate will be based at APC and integrated in the ANTARES/KM3NeT team, where (s)he will be supervised by Dr. V. Van Elewyck. (S)he will be responsible for the implementation in the KM3NeT software suite developed at APC of the additional tools needed for Earth tomography studies. (S)he will also work in close contact with Prof. E. Kaminski (IPGP) who will him on the state-of-the-art current questions concerning the structure and composition of the deep Earth. The applicant is expected to build on this double expertise to orient the sensitivity studies and the interpretation of the first measurements with KM3NeT data data towards the most relevant geophysics questions. It is expected that (s)he will present his results in major conferences both in astroparticle physics (Neutrino 2020, ICRC 2021) and geophysics (AGU, EGU Meetings).

The position will require frequent travels to KM3NeT Collaboration meetings and smaller workshops, namely 3-4 per year. Participation in KM3NeT maintenance/operation service tasks (including both remote and on-site shifts) is also required. A high level of motivation is expected, and a teamwork attitude and good communication skills are also very desirable. Some initial knowledge of C++/PYTHON coding, computing, particle physics data analysis (e.g. with the ROOT software) and statistical methods is highly appreciated for the position.



References:

[1] S. Adrián-Martínez et al. [KM3NeT Collaboration], *Letter of Intent for KM3NeT Phase 2* J.Phys. G43 (2016) no.8, 084001
[2] S. Bourret and V. Van Elewyck [for the KM3NeT Collaboration], *Earth tomography with neutrinos in KM3NeT-ORCA*, EPJ Web Conf. 207 (2019) 04008