Recherche multi-messager de sources de neutrinos cosmiques de haute énergie avec le télescope à neutrinos ANTARES.
Multi-messenger search for high energy cosmic neutrino sources with the ANTARES neutrino telescope.

High-energy neutrinos provide a unique tool to observe the non thermal Universe. They are produced in high-energy hadronic interactions and can travel undisturbed over cosmological distances. Detection of a high-energy astrophysical neutrino source would in particular unambiguously identify one of the so far unknown acceleration sites of high-energy cosmic rays.

Neutrino telescopes consist in the instrumentation of large volumes of water (or ice) with photomultiplier (PMTs) to detect the Cherenkov radiation emitted by charged leptons (mainly muons, but also electron- or tau-induced showers) induced by cosmic neutrino interactions with the target transparent medium, inside or near the instrumented volume. PMTs signals (timing and amplitude) are used to reconstruct the muon trajectory and the energy of the parent neutrino. In order to reduce the background due to the intense flux of down-going atmospheric muons present at ground, such detectors are buried deep under the surface. Moreover, since the Earth acts as a shield against all particles but neutrinos, their design is optimized for the detection of up-going muons produced by neutrinos which have traversed the Earth and interacted below the detector.

The ANTARES detector consists of ~900 PMTs distributed along 12 vertical lines of 25 storeys each, weighted to the sea bed at a depth of 2500m in the Mediterranean. The detector is complete since May 2008 and the collaboration now concentrates on the data analysis. ANTARES is today the most sensitive detector in its hemisphere, thus providing an unprecedented sensitivity to the Southern Sky. This region of the sky contains the galactic center and a large fraction of the galactic plane and hence the majority of potential nearby TeV sources. The APC group is strongly involved in the analysis, coordinating several working groups within the collaboration.

The group has particular interest and experience in the search for cosmic neutrinos in coincidence with other messengers. The goal of such multi-messenger approach is to maximize the discovery potential of ANTARES by developing joint analyses based on timing and/or direction coincidences with other messengers such as gravitational waves or high-energy gamma rays, thus reducing the associated backgrounds and hence and making both experiments more sensitive. In particular this approach can provide (be it through signal detection or constraining limits) a better understanding of the yet poorly understood Gamma Ray Bursts (GRB). Following this spirit, a Ph.D student joining our group would have the opportunity to develop original studies and collaborative works with other experiments. In this context, the student would also benefit from the proximity in the laboratory of several experimental and phenomenological groups studying high energy astrophysical sources and in particular GRB. Throughout this Ph.D. project, the student will become familiar with current issues in high energy astrophysics and cosmic rays, while acquire a solid background in Computer Science (C + +, ROOT, databases) and in the statistical methods required in data analysis.

The position, funded by Region “Ile de France”, can be open as early as October 2013.

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