

Particle physics with neutrino telescopes: dark matter and neutrino mass hierarchy

Research Project / Research Group Description:

Neutrino telescopes are a fundamental player in the increasingly-rich field of multi-messenger astronomy. The combination of experimental efforts to study the Cosmos has historically boosted our knowledge of it. This effort has now been strengthened with two experimental techniques that have entered a mature stage: neutrino astronomy and gravitational waves. The high-energy neutrino signal detected by IceCube or the recent observation of a neutron star merger in different channels (gravitational waves, optical, X-rays, etc.) are just a starting point to understand fundamental questions in astrophysics like the origin of cosmic rays or the mechanisms under the most catastrophic events in the Universe. KM3NeT, successor of ANTARES, is the perfect tool to move forward, thanks to its size, target medium and location.

The ANTARES/KM3NeT research team at IFIC has a long experience in undersea neutrino telescopes, where it is involved in a variety of tasks. The group has built and operated the time calibration system based on optical beacons. It has led the search for neutrino point sources in ANTARES and is presently deeply involved in the indirect search for dark matter using cosmic neutrinos. The team participates also in the KM3NeT telescope which is being deployed in the Mediterranean Sea. Members of the IFIC group have relevant coordination responsibilities in both collaborations.

Job position description:

We propose two main possibilities as analysis topic, both related to the capabilities of neutrino telescopes to study two of the most relevant issues in physics today: dark matter and neutrino mass hierarchy.

Dark matter:

- Search for dark matter annihilation in the Sun with the ANTARES data.
- Search for dark matter annihilation in the Galactic Centre and halo.
- Preparation of the search of dark matter with the KM3NeT neutrino telescope, both in its ORCA and ARCA versions.

Neutrino mass hierarchy:

- Study of the sensitivity of KM3NeT-ORCA for the determination of the neutrino mass hierarchy.
- Study of the capability of KM3NeT-ORCA for the measurement of other oscillation parameters as θ_{23}

In addition, the student will also contribute to the time calibration of the KM3NeT telescope.

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Research project/Research Group website

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