Dark Matter search with ANTARES

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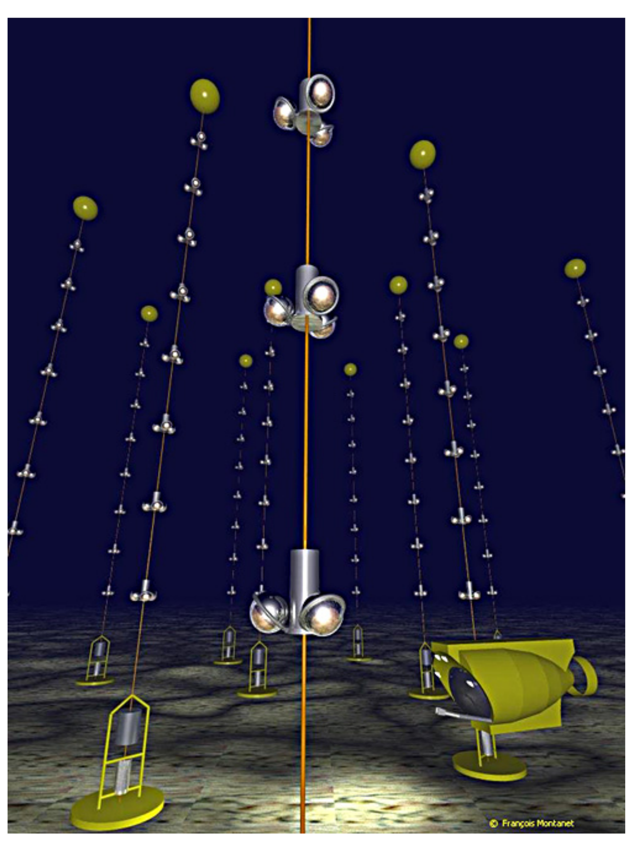
Objectives

The main purpose of this thesis is to search with ANTARES data for high energy neutrinos (10-1000 GeV) coming from the Sun that could be due to annihilations od dark matter trapped in the Sun.
For having good results, it would be crutial to improve the track reconstrution algorithm from the information of the sensors at 'low' energy, so being able to obtain the direction of neutrinos.

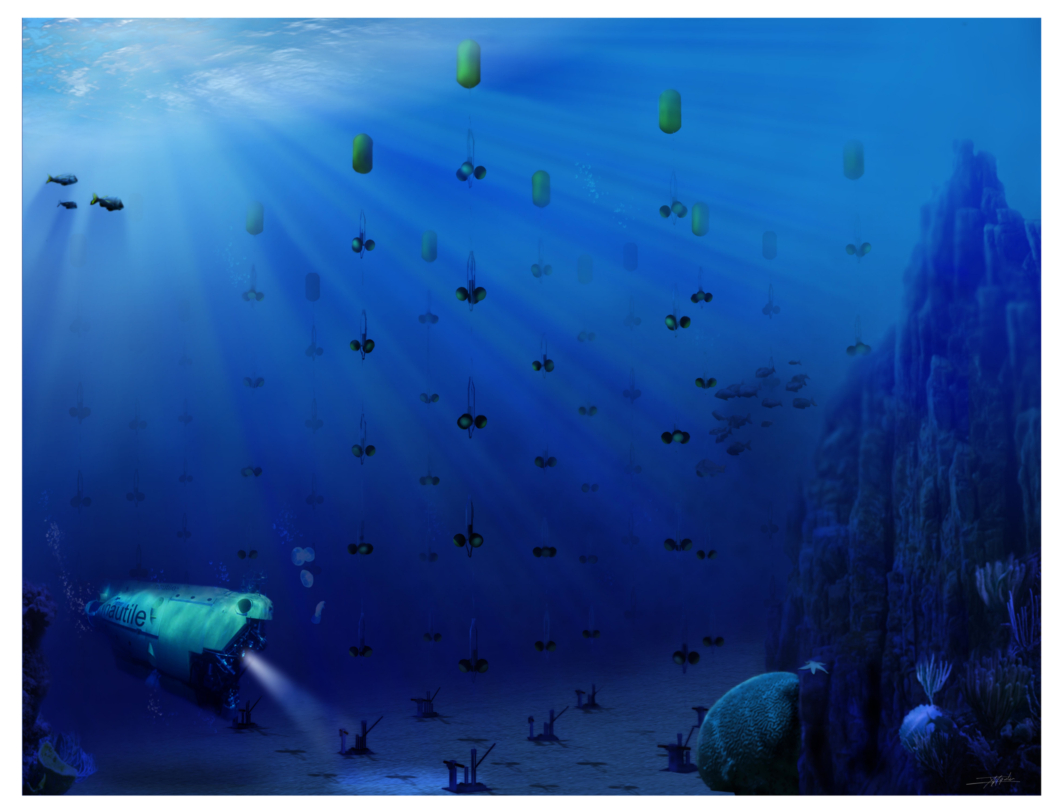
Plans

- To improve the single line events reconstruction, which usually corresponds to low energy events. Due to the configuration of the detector to obtain the azimuth information is quite challenging in this case. Both, standard reconstruction techniques as well as machine learning tools are used for this.
- Use the improved reconstruction to obtain better results in the dark matter search.
- Use all these information and experience for future DM studies with KM3NeT, a larger neutrino telescope that is under costruction.

The ANTARES telescope

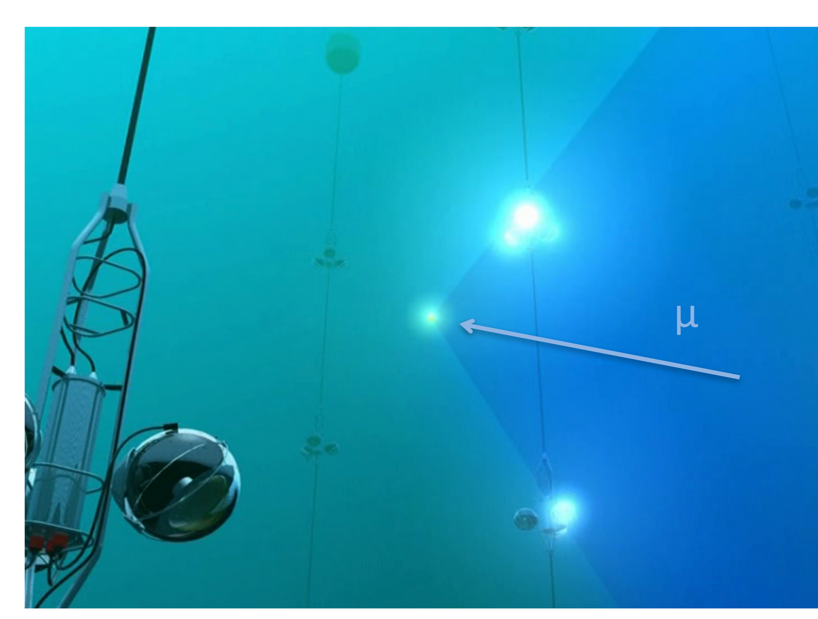


ANTARES (Astronomy with a Neutrino Telescope and Abyss environmental RESearch) is a neutrino telescope detector 2.5 km depth in the Mediterranean Sea off the coast of Toulon, France. It is designed to be used as a directional neutrino telescope to locate and observe neutrino fluxes from cosmic origins in the direction of the Southern Hemisphere of the Earth.
It is composed by long string anchored on the sea bed. Each of these lines is composed by 12 floors, where in every floor there are 3 PMT.



The detection principle

The detection of neutrinos is based on the measurement of the Cherenkov light emitted by the secondary particles produced by the interaction with the neutrino with the matter.Although the neutrino has a very small cross-section, it can interact with matter (water in this case) and other relativistic charged particles, such as muons, are produced by interaction, which in turn produce Cherenkov photons that are detected by optical modules. From the time and position of the photons detected it is possible to reconstruct the track of the muon, and thus of the neutrino since they have high energy.



Dark Matter

Unlike normal matter, Dark Matter does not interact with the electromagnetic force. This means it does not absorb, reflect or emit light, making it extremely hard to spot.
At present dark matter composes 23% of the Universe which is around five times larger than the 4.6% of baryonic matter. The remainder of the energy density of the Universe is comprised of dark energy.

Indirect search of Dark Matter

There are three ways to detect Dark Matter: production in accelerators, direct and indirect detection. Antares uses the indirect type, which consist in looking for signals of annihilations of dark matter particles. These searches concentrate on massive celestial objects in which an excess of dark matter is expected.
ANTARES, thus, search for excesses of neutrino fluxes that are resulting from dark matter annihilations according to some theoretical models.

Conclusions

- Dark matter is one of the more important open questions in physics nowadays.
- A search for neutrinos in the Sun that could come from dark matter annihilations will be done.
- This could bring some light in the nature of dark matter, or at least to constrain some models. Stay tuned.

References
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