KM3NeT: studying neutrinos in the ocean depths

Research Field
Multimessenger astrophysics

Project Suitability
PhD
Honours

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KM3NeT is a cubic kilometre experiment being constructed at the bottom of Mediterranean Sea. It is designed to detect neutrinos – almost massless subatomic particles – using the flashes of light they give off when they interact. By detecting them, KM3NeT will study the origin of the highest-energy particles in nature – cosmic rays – and resolve a long-standing question of particle physics, the neutrino mass hierarchy.

The Curtin Institute of Radio Astronomy is collaborating with the European consortium constructing KM3NeT. Neutrino telescopes primarily look downwards, through the Earth – and so KM3NeT sees the same sky as in Australia. Our aim is to identiy the astrophysical events producing the neutrinos KM3NeT detects, be they hypernovae, accreting black holes, neutron star mergers, or something as-yet unknown. Several projects are available in 'multimessenger astronomy', using astronomical expertise to study proposed cosmic ray/neutrino sources, and understanding how to use KM3NeT to search for them. The predecessor of KM3NeT, ANTARES, has been operating for ten years, and its data are available for developing analysis methods to be used with KM3NeT.

The key aims of the project will be:

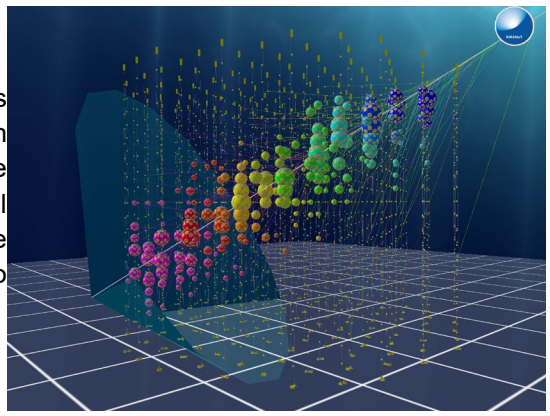
(i) Understand how KM3NeT detects neutrinos, and how to reconstruct their properties

(ii) Develop tests of neutrino production in astrophysical sources

(iii) Apply these searches to first data from KM3NeT phase 1, and archival data from ANTARES

Projects targeting particle physics, such as searches for supersymmetry and charm-meson decay, are also available.

Successful applicants will be expected to travel to Europe to attend collaboration meetings, and be willing to spend a one-month exchange at collaborating institutes (e.g. in Italy, Spain, Netherlands, France, and/or Germany), as appropriate to the project. They should also be prepared to collaborate with expert astronomers from radio, optical, and other backgrounds, as required for astrophysical modelling.



Simulation of a neutrino event in KM3NeT. The neutrino interacts to produce a muon (thick beige line) which travels through KM3NeT, producing Cherenkov light (thin coloured lines; cone indicates shock front). This light is detected by KM3NeT optical modules (circles). The time (blue: early, red: late) and magnitude (size of circles) of the photon signature can be used to reconstruct the original neutrino's energy and direction.