Study of the effect of environment on GeV neutrino emission in hadronic cosmic accelerators

Contacts : Gwenhaël de Wasseige
gdewasse@apc.in2p3.fr
Véronique Van Elewyck
elewyck@apc.univ-paris7.fr, 01 57 27 69 56

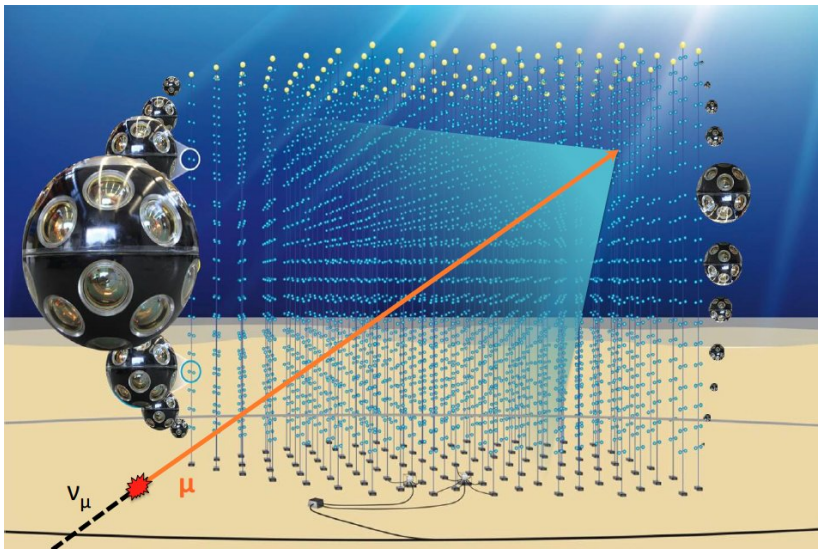
Master internship project proposed by the KM3NeT group at Laboratoire Astroparticules et Cosmologie (APC)

Since 2013 and the first observation of high-energy astrophysical neutrinos in the IceCube Neutrino Observatory[1], neutrinos constitute a new messenger to study the extreme Universe, and large neutrino telescopes have been working towards the identification of sources. While recent multi-messenger observations suggest that blazars may be the first identifiable sources of this observed neutrino flux[2], other source populations emitting neutrinos remain unidentified.

Bearing in mind the decreasing character of this flux with the increasing energy, we propose to lower down the energy range to the GeV level in view of probing a larger neutrino flux and thus allowing the identification new astrophysical neutrino sources. GeV neutrinos are expected to be produced by proton-neutron collisions happening in dense astrophysical objects[3]. They offer, besides an evidence of hadronic acceleration mechanisms, a probe of the amount of matter surrounding the astrophysical object and may therefore allow a more complete understanding of its intrinsic nature.

We propose a master internship (M1 or M2, adaptable to the level of the candidate) to perform a simulation (Geant4) of GeV neutrinos production. The simulation will be used to study the influence of the environment (density, composition, distance to the source,...) on the resulting flux. The candidate will have to identify parameters that may influence the neutrino production at low energy. He/she will then implement them using realistic values in the simulation and derive the corresponding neutrino flux.

The goal is to evaluate the variation of the neutrino flux for each studied parameter. An extension to high-energy neutrinos and electromagnetic emissions can be foreseen to get the global picture. The candidate will be able to work in collaboration with the KM3NeT group at APC and will be asked to present the progress made along the weeks. Through this work, he/she will become familiar with state-of-the-art questions in neutrino astronomy as well as multi-messenger astronomy, while acquiring some experience in programming (C++, ROOT, Geant4,…).



[1] The IceCube Collaboration, Science 22 Nov 2013:Vol. 342, Issue 6161, 1242856.
[2] The IceCube Collaboration et al., Science 12 Jul 2018:eaat1378, The IceCube Collaboration, Science 12 Jul 2018: eaat2890
[3] K. Asano, K. Murase, Adv. Astron. 2015, 568516 (2015), J. Bahcall, P. Mészáros, Phys. Rev. Lett. 85, 1362 (2000)