Université de Paris

Master project in "Data Intensive Astroparticle Physics"

Astroparticule et Cosmologie (APC)

Data Intelligence Institute of Paris (diiP)

Context

The focus of this project is on a search for a connection between high-energy neutrinos and gamma rays in the extragalactic sky. Astrophysical objects are known to emit photons in a wide range of energy, starting from radio waves up to energetic gamma rays following thermal and non-thermal processes. The presence of non-thermal processes creating energetic gamma rays is due to the acceleration of charged particles in the vicinity of the astrophysical objects. Most observations agree with the presence of leptonic processes, pointing back to the presence of fast-moving electrons. Some observations instead can also include a hadronic component, pointing back to the presence of fast-moving protons. The presence of fast-moving protons in astrophysical environments can be inferred by the direct observations of high-energy neutrinos resulting from proton-proton and proton-photon interactions at the location of the astrophysical object. Two large observatories have been designed to be able to detect high-energy neutrinos from astrophysical environments: IceCube and KM3NeT. IceCube already has collected 10-years of data, which resulted in a catalogue of neutrinos having a high probability of being of cosmic origin, while KM3NeT is an observatory under construction. The significance of the signal of IceCube cosmic neutrinos shows that still no firm conclusion can be drawn on the association of these with astrophysical objects.
There are two ways of tackling the mystery of neutrino production in astrophysical objects: a direct search and an indirect search. The direct search mode is to wait until IceCube/KM3NeT will acquire enough statistics to be able to have a significant signal associated with the position of known astrophysical objects, the drawback of this method being that this could take time, of the order of decades. The indirect search mode is to use complementary analysis approaches, as the follow-up approach and the statistical inference approach.

This Master project concerns an indirect search for neutrino associations with astrophysical objects using a statistical inference approach. The project takes advantage of published neutrino lists together with astrophysical objects catalogues and open data from the Fermi observatory. Technically, the project needs the development of a full Python analysis chain using Deep Learning.

Project's acronym: GammaNu
Placement: University of Paris, Astroparticule et Cosmologie laboratory (APC) and Data Intelligence Institute of Paris (diiP)

Description of Group/Laboratory/Supervision

This Master project will be supervised by Yvonne Becherini, Professor at the University of Paris, and will take place within the High-Energy Astrophysics (AHE) group of the AstroParticule and Cosmologie Laboratory and the Data Intelligence Institute of Paris (diiP).

Training and skills required

- Being enrolled in Master education in Physics or Astronomy
- Python programming
- Good command of English

Contact

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