University "La Sapienza", PHD in Physics – A.A. 2019-2020

Course: High Energy Neutrino Astrophysics – 3 credits (20 hours)

Prof. Antonio Capone

Composition and energy distribution of Cosmic Rays (CR): the "C.R. puzzle" at UHE ($E > 10^{19}$eV). Interaction of UHE protons and photons with the Universe matter and/or radiation (GZK effect). CR acceleration mechanisms. "Leptonic" and "Hadronic" sources of high energy C.R.

Brief discussion of astrophysical results obtained, and expected in future, with High Energy photons (experiments ARGO, MILAGRO, HESS, MAGIC, VERITAS, CTA, LHAASO, …) and with H.E. protons (experiments AGASA, HiRes, AUGER, Telescope Array, …).

Motivations for the "neutrino astronomy", the role of high energy astrophysical neutrino detection in the "multimessenger astrophysics".

Cherenkov detection of High Energy astrophysical neutrinos: the detection principle and technique, experiments Baikal, AMANDA/IceCube, ANTARES, KM3NeT, ….

Astronomy with neutrinos:

- search for galactic (microquasars, SuperNova Remnants , Galactic Centre (CG), …) and extragalactic point like sources (Active Galactic Nuclei, SNR, Gamma Ray Bursts, … ;
- search for "diffuse" astrophysical neutrino fluxes;
- indirect search for "dark matter" by searching for neutrinos from the Sun, from the GC, from the Earth centre;
- neutrino oscillations: the effect on the atmospheric neutrinos and on astrophysical neutrinos
- Neutrino Telescopes and the study of neutrino intrinsic properties (KM3NeT/ORCA and the neutrino mass hierarchy)

Acoustic detection of neutrinos with $E_\nu > 10^{19}$ eV: detection principle, status and perspectives.