HIGH PRECISION NEUTRINO OSCILLATIONS

From the discovery of neutrinos (1956, Nobel prize 1995), reactor neutrinos have played a critical role in the progress of our understanding of leptonic sector of the Standard Model of Particle Physics (SM), most recently in the context of the characterisation of the neutrino oscillation phenomenon (Nobel prize 2015). Neutrino oscillations is still regarded as one of the most promising scenarios for evidence (directly or indirectly) for physics beyond the SM — typically via high precision measurements. The recent discovery of a large θ_{13} is the latest successful example, where the Double Chooz (France) has had key role. Double Chooz together with the Daya Bay (China) and the RENO (South Korea) experiments are now aiming to combine their results towards the world best θ_{13} measurement — likely the leading result for several decades ahead. Both the precision and accuracy of θ_{13} are critical to indirectly constraint leptonic CP-violation — as well as other parameters — upon combination with other experiments. The future of reactor neutrinos points towards the largest liquid scintillator ever built envisaged for the JUNO experiment, inheriting design lessons from the two Nobel price wining experiment SuperKamiokande and SNO as well as some innovative ideas — a few proposed by the APC laboratory. JUNO, located in the tropical South of China (near Macao / Hong Kong), is in a word leading position to perform several unique high precision measurements, such as the solar sector parameters (θ_{12}, δm^2), atmospheric Δm^2, including the best constraint of atmospheric Mass-Hierarchy in vacuum. JUNO is, in fact, the only experiment able to observe both solar and atmospheric oscillations simultaneously. Due to its size, JUNO will also be one of the best detectors (high statistics) for supernova neutrinos and geo-neutrinos detection as well as being an excellent proton-decay searcher.

The researchers from the APC laboratory are in the world leading edge of reactor neutrino physics, leading both the Double Chooz and some key aspects of the JUNO experiments. The interested candidate is proposed to yield an PhD thesis degree in experimental particle physics in the context of both reactor neutrino experiments. First, we expect participation to Double Chooz final θ_{13} measurement [1] as well as learning the basic physics of reactor neutrinos in our local detector and laboratories in France — LNCA laboratory. Second, the thesis final results are expected to focus on the APC leading operations within JUNO: optimisation of the novel Double Calorimetry [2] and the novel Occulting Light Concentrator concept [3] detector design — both conceived by APC researchers. Both techniques are expected to make JUNO the highest precision liquid scintillator calorimeter ever built for neutrino physics, thus allowing high precision physics with the first data — expected by early 2020. Studies towards the best measurements of the solar neutrino measurements as well as supernova neutrinos [4] in collaboration with the APC Prof. Cristina VOLPE (renown supernova phenomenologist) are prospected as main goals. The PhD work is expected to take place in a very international environment — English is a must — in tight collaborators with other CNRS laboratories and other laboratories across globe — Brasil, China, Germany, Italy, Japan, Spain, etc.

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REFERENCES:

[1]: Latest data release of Double Chooz @ CERN (https://indico.cern.ch/event/548805/) — publications soon.
[2]: Double-Calorimetry @ NEUTRINO 2016 Conference (London, UK)
[3]: Occulting Light Concentrators @ NEUTRINO 2016 Conference (London, UK)
[4]: arXiv:1303.1681 ("Open issues in neutrino astrophysics")