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Financement demandé : Ecole Doctorale STEP UP

Sujet de Thèse :

"Neutrinos : from the discovery of the diffuse supernova neutrino background to new physics"

Neutrinos are elementary massive particles with mixings. They change their flavor while propagating. The vacuum oscillations discovered in 1998 by the Super-Kamiokande Collaboration is a breakthrough, with an impact in particle physics, astrophysics and cosmology. Open questions remain including the neutrino mass, mass ordering and nature, the neutrino magnetic moment, the existence of sterile neutrinos, of CP violation in the leptonic sector and of non-standard interactions. Weakly interacting neutrinos tell us about the primordial Universe and dense environments, such as exploding stars (core-collapse supernovae) or binary compact objects (neutron star-neutron star, black hole-neutron star).

The PhD Thesis will be focused on theoretical neutrino physics and astrophysics and involves both theoretical and phenomenological aspects. Unexpected novel phenomena occur in dense environments, due e.g. to neutrino-neutrino interactions that make neutrino flavor evolution a non-linear many-problem. These aspects are intriguing in their own right and can influence observations. In particular, predictions of the neutrino spectra are essential for the upcoming discovery of the diffuse supernova neutrino background by the running Super-Kamiokande+Gd and the upcoming JUNO and Hyper-Kamiokande experiments. Neutrinos also impact supernovae explosions and r-process nucleosynthesis, in core-collapse supernovae and kilonovae.

The Thesis will be devoted to the investigation of neutrino properties and of neutrino flavor evolution both theoretically and for their phenomenological impact, e.g. in order to explore what we will learn from the upcoming measurement of the diffuse supernova neutrino background.

An M2 internship on the topic is also possible.