Title: “Exploring the jet substructure in pp and Pb-Pb collisions at LHC energies with ALICE”

The ALICE experiment has been optimized to study collisions of heavy nuclei at the LHC, the world’s largest and most powerful particle accelerator currently in operation at CERN, only 140 km from Grenoble. By smashing together fully stripped lead ions at LHC energies, and re-creating for a brief period of time the conditions of the early Universe in the laboratory, nuclear matter is momentarily transformed into a strongly-coupled Quark-Gluon Plasma (QGP).

One of the striking features of this novel state of matter is its opacity to QCD jets (the so-called *jet quenching* phenomenon) which, in turn, probe the microscopic structure of the dense medium created in heavy-ion collisions and, consequently, shed light on the inner workings of QCD at high densities and temperature. The modification of jet yields and structure in heavy-ion collisions relative to elementary pp collisions provides new handles to study the medium-induced radiation pattern, as well as to quantitatively control the impact of non-perturbative (hadronization) and underlying-event contributions to the jet substructure. Further exploitation of such observables for, e.g., light-quark, gluon, and heavy-quark jet discrimination can open a new window to better understand the color factor and mass dependence of jet quenching.

The measurement and identification (tagging) of jets is experimentally challenging in the high multiplicity environment of heavy-ion collisions, although the excellent tracking capabilities of ALICE allow to fully reconstruct jets in a wide kinematic regime and to resolve substructure at small angles.

This internship, based on Monte Carlo simulation tools (JEWEL, QPYTHIA or JETSCAPE), is aimed at studying jet substructure observables as implemented in the FastJet package. Given the proliferation of existing jet substructure variables related to the complex and rich structure inside jets, developing new (deep) machine-learning methods now being widely investigated by the ALICE Collaboration, are expected to significantly enhance the sensitivity of substructure analyses. Comparison of these observables with the state-of-the-art perturbative QCD predictions will ultimately help constraining and distinguishing between jet-medium interaction mechanisms dominant in heavy-ion collisions at the LHC.

Data analysis skills using C++, ROOT, and Python or equivalent are essential to the successful completion of this internship. The intern would eventually have the possibility to present on regular basis his/her results at ALICE meetings.

The internship will be followed by a PhD co-supervised between the University Grenoble Alpes (UGA) and the University of Tsukuba (Japan) already funded by the UGA “Initiative d’excellence” (IDEX) International Strategic Partnerships starting from September 2020.

Keywords: Particle physics – QGP – LHC – Jets – Substructure – Machine learning
Level: Master 2
Starting date: March 1st 2020
Duration: 4 months with a possible extension up to 6 months