

INTERNSHIP PROPOSAL

Laboratory name: **Institut de Physique Théorique (IPhT)**

CNRS identification code: UMR 3681

Internship director's surname: **Edmond Iancu**

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Internship location: **IPhT, CEA Saclay**

Thesis possibility after internship: YES

Funding: NO

If YES, which type of funding:

Title: Mining for gluon saturation at high energy colliders

Gluon saturation is an emergent phenomenon in QCD at high energy and for large nuclei. When a proton is accelerated to a very high energy, its three constituent ("valence") quarks copiously radiate "soft" gluons with lower energies, which in turn radiate other gluons which are even softer, and so on, thus eventually generating a system with high gluon density. In a large nucleus like gold or lead, this density is further enhanced by the presence of a large number $A \gg 1$ of protons and neutrons, which act as sources for the gluon cascades. Eventually, the gluon density becomes so large that non-linear phenomena like gluon recombination are expected to become important. The competition between gluon radiation and gluon recombination leads to a dynamical equilibrium known as *gluon saturation*. This phenomenon has far reaching, conceptual and phenomenological, implications.

Although predicted by QCD perturbation theory and indirectly confirmed by a variety of data (from electron-proton collisions at HERA to proton-nucleus and nucleus-nucleus collisions at the LHC), the phenomenon of gluon saturation has never been *directly* observed. This internship (that could be followed by a PhD thesis) proposes to explore a new class of observables, like di-jet production in electron-nucleus or proton-nucleus collisions, which are sensitive to gluon saturation via the *correlations* between the produced particles. These observables will be measured in the future experiments at the Large Hadron Collider (LHC, CERN) and the Electron-Ion Collider (EIC, USA).

During the internship, the student should familiarise him(her)self with modern approaches, like the Color Glass Condensate effective theory, for the description of hadronic wave-functions and of high-energy scattering in the presence of gluon saturation. He/she will be encouraged to compute relatively simple processes like di-muon production in proton-nucleus collisions and to develop numerical methods for the efficient evaluation of the analytic results.

The candidate should be familiar with the foundations of quantum field theory. A basic knowledge of QCD and some familiarity with programming techniques would be useful.

Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:

Condensed Matter Physics: NO Soft Matter and Biological Physics: NO

Quantum Physics: YES

Theoretical Physics: YES