Master 2: ***International Centre for Fundamental Physics***

INTERNSHIP PROPOSAL

Laboratory name: LPENS
CNRS identification code: UMR 8023
Internship directors: Lucas Pinol and Vincent Vennin
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Web page: https://www.lpens.ens.psl.eu/research/astro/equipe-20/?lang=en
Internship location: LPENS, 24 rue Lhomond 75005 Paris

Thesis possibility after internship: NO

Phase-space approach to primordial non-Gaussianities

There is little doubt that inflation correctly describes the first moments of our cosmic history. Yet, the precise physics of inflation remain elusive. What were the particles at play in the early universe? What were their masses, spins and which kinds of interactions were amongst them? The standard model of inflation has yet to be constructed.

Primordial non-Gaussianities carry the hope to shed light on the physics of the early universe. Those tiny deviations from Gaussian statistics in the distribution of primordial fluctuations—probed in the Cosmic Microwave Background and Large-Scale Structures—originate from inflationary non-linearities. The cosmological collider program aims at identifying specific imprints of primordial fields and their characteristics in the cosmological data beyond the 2-point function.

During this internship (which cannot be *immediately* followed by a PhD thesis), we will develop a novel approach to the computation of primordial non-Gaussianities in models of inflation featuring several degrees of freedom—so-called non-linear sigma models of inflation—by directly considering phase-space fluctuations in a Hamiltonian formulation. The other approach, which is already well-developed, amounts to working at the level of the Lagrangian, and then switch to the Hamiltonian in the perturbative theory. However, it has been understood that, when working directly in terms of the observable curvature fluctuation, so-called boundary terms in the action led to ambiguous definitions of the interaction Hamiltonian. Working directly at the level of the phase space should enable to circumvent this difficulty and handle the meaningful and physical phase-space variables. This approach is also particularly adapted to the study of quantum aspects of cosmological fluctuations, such as decoherence.

This internship will be the opportunity for the intern to develop their knowledge about primordial physics, general culture in cosmology and more specific skills related to gauge ambiguities, phase-space covariance, Schwinger-Keldysh “in-in” formalism and aspects of quantum field theory in curved spacetimes. An excellent knowledge and understanding of general relativity, background cosmology and flat spacetime quantum field theory is required. The Gravitation and Cosmology group at LPENS is a young and lively group with regular seminars and journal-clubs. Interactions with other groups at LPENS (Astrophysics, Fundamental Interactions, etc.) will be encouraged. The internship will be co-directed by Lucas Pinol and Vincent Vennin.

Candidates should reach out with their CV and a letter of motivation (1 page max) stating their interests.

Condensed Matter Physics: ~~YES~~/NO Soft Matter and Biological Physics: ~~YES~~/NO
Quantum Physics: ~~YES~~/NO **Theoretical Physics:** **YES**~~/NO~~