INTERNSHIP PROPOSAL

Laboratory name: AIM, CEA-Saclay
CNRS identification code: UMR7158
Internship director'surname: Sandrine CODIS (co-encadrant Alexandre Barthelemy)
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Web page:
Internship location: Laboratoire Cosmologie et Evolution des Galaxies, AIM/CEA-Saclay

Thesis possibility after internship: YES
Funding: YES If YES, which type of funding:
remuneration du stage sur fonds propres

Title: The biased Cosmic web, from theoretical modelling to observations

Summary (half a page maximum):

Context: The study of the Large-Scale Structure of our Universe (also refered to as the filamentary Cosmic Web) is a paramount aspect of modern research in cosmology. With the advent of extremely large and precise cosmological datasets which are now (or within months) coming notably from the Euclid space mission, it becomes feasible to study in detail the formation of cosmic structures through gravitational instability. In particular, fine non-linear aspects of this dynamics can be studied from a theoretical point of view with the hope of detecting signatures in real observations. One of the major difficulty in this regard is probably to make the link between the observed distribution of galaxies along filaments and the underlying matter distribution for which first-principles models are known. Eventually, observing finely the "biased" cosmic web from galaxy surveys could in principle allows to probe the cosmological model (being it the concordant one or its extensions) along with the galaxy-dark matter connection.

Proposed work: Building on recent and state of the art theoretical developments in gravitational perturbation theory and constrained random field theory, the successful intern will develop first-principles predictions for statistical observables (extrema counts, topological estimators, extrema correlation functions, e.g. Pogosyan et al. 2009, MNRAS 396 or Ayçoberry, Barthelemy, Codis 2024, A&A 686) of the cosmic web, applied to the actual discrete field of galaxies which only traces the total matter in a biased manner. This work, challenging from a theoretical point of view, will nevertheless pave the way to use the full observational power of the observed galaxy distribution, not only focusing on the statistics of the amplitude of the field, but also its joint dependence with its derivatives that account for tidal and environmental effects. The candidate could continue this work in a PhD thesis, for which developments to redshift space could be envisioned. Indeed, the previous work, while already advanced, does not take into account the fact that galaxies have proper velocities on top of the Hubble flow, which makes their distance estimation through redshift more complex and produce well-known distortion in the distribution of galaxies. They will thus further develop their model in redshift space, allowing for anisotropic fields in the formalism (which adds an extra degree of complexity as shown for instance in Codis et al. 2013, MNRAS, 435).

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: NO Theoretical Physics: YES