

INTERNSHIP PROPOSAL

(One page maximum)

Laboratory name: IP2I

CNRS identification code: UMR 5822

Internship director'surname: DARMÉ

e-mail: l.darme@ip2i.in2p3.fr

Phone number: 0472448233

Web page: <https://particularly.fr/lucdarme/home/>

Internship location: Lyon

<https://www.ip2i.in2p3.fr/equipes/theorie/>

Thesis possibility after internship: YES

Funding: NO

Custodial scalars: "organised" scalar potentials and the hierarchy problem

Scale hierarchies are a cornerstone of our understanding of the natural world. They come particularly into play in the study and minimisation of scalar potentials, whose importance in particle physics became obvious with the Higgs boson discovery.

Yet, as was realised quickly during the construction of the Standard Model of particle physics (SM), quantum scalar potentials are quite adverse to involving more than one given scale at the time. Within the SM, this led to the (in)famous hierarchy problem and to the theoretical search for mechanisms protecting the electroweak (EW) scale from the large quantum corrections that occurred whenever the theory was extended with another scale [1]. Symmetries have been at the forefront of these efforts, whether in supersymmetric, composite or extra-dimensional constructions.

With our groups at IP2I, we have worked on various such solutions. We recently explored more specifically the idea that most scalar field potential can be organised systematically in a "maximally-symmetric" fashion. By leveraging tools called "moment maps", one can sort the scalar potential as an ordered tree of increasingly symmetric operators. This allows for the generation of light scalars quite naturally, in a spirit close to existing ideas such as Little Higgs [2].

During this internship, two main research directions may be pursued. First, promising results in solving the little hierarchy problem have been obtained in a simple model of an extended Higgs sector. A thorough study of the existing constraints and prediction for the electroweak precision observables must be undertaken. Second, since the mechanism only generate scale hierarchies of about one to two orders of magnitude, a key question is whether it can be linked to another solution for the full hierarchy problem. Models with extra-dimensions will be an interesting starting point.

Interactions with the rest of the theory group at IP2I is expected, the supervision will be shared with Florian Nortier. This internship may be continued by a PhD project pending but independent funding must be secured a priori.

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