SEMPARIS – Séminaires en région parisienne

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Cours

Mercredi 11 Octobre 2023, 10 :00
IPHT, Salle Claude Itzykson, Bât. 774
Domaines : physics

Titre : *Naturalness in Quantum Field Theory after the Large Hadron Collider*

Orateur : **Raffaele Tito D'agnolo (ipht) (IPhT)**

Résumé : *The two parameters of the Standard Model that have the strongest impact on physics at low en- ergy are also the most sensitive to the details of the theory at high energies. They are the cos- mological constant and the Higgs boson mass. Experimentally they are both associated to energy scales that we can measure. Theoretically they force us to ask questions about physics at higher energies, possibly all the way to the Planck scale.*

At the moment it is very hard to understand their measured values. The difficulty has the same origin for both parameters and can be traced to the symmetries of fundamental interactions. A prediction based on symmetry gives results that are 120 orders of magnitude too large for the cosmological constant and 34 orders of magnitude too large for the Higgs mass. The course starts with a brief review that makes the meaning of these estimates precise and discusses to what ex- tent we have a problem in the theory of fundamental interactions. In the first two lectures I will show that the resolution of this apparent failure of symmetry is guaranteed to teach us something qualitatively new about Nature.

I will then discuss theories that can successfully predict the value of the Higgs boson mass, includ- ing traditional attempts based on supersymmetry and scale invariance. However, the emphasis will be on modern ideas that involve the evolution of the Universe. I will also review some incom- plete, but stimulating proposals based on more radical departures from standard effective field theory arguments. This includes possible UV/IR mixing effects, inspired by string theory, or the role of non-invertible symmetries. The broader aim of this second part of the course is to give a comprehensive overview

of all conceptually distinct possibilities that are still viable experimen- tally. In the process I will comment on which (very small) subset of these ideas can explain also the value of the cosmological constant.
