Unraveling Gauge theories and Effective Field theories though the high energy frontier

Research Project / Research Group Description:
The Large Hadron Collider (LHC) at CERN is exploring the fundamental components and interactions of matter at the highest energies. However, besides the great success of the discovery of the Higgs boson in 2012, the LHC data do not show a clear signal of the awaited new physics scenarios and leaves many questions unanswered such as for example the nature of the still undetected dark matter or the prevalence of matter above antimatter in our Universe. These facts call for pushing forward our knowledge on the theoretical side, thus breaking current limitations in the precision and model building frontiers.

The research project will be focused in the development of a new theoretical framework covering both perturbative and non-perturbative aspects of Quantum Field Theory. On the perturbative side our group has recently proposed a new method, known as loop-tree duality, that allows to maintain the four dimensions of space-time in theoretical computations by establishing a direct correspondence between quantum states that are experimentally equivalent but are treated differently in Quantum Field Theory. We are also leading experts in Effective Field theories and have contributed with seminal developments in this sector. Recent studies of the Higgs and multi-Higgs boson theories had an impact in the field.

The fellow will explore new theoretical applications of the loop-tree duality, such as multi-loop developments, asymptotic expansions, the interplay with Effective theories and the colour-kinematics dual correspondence with gravity. Besides relevant phenomenological implications, the goal of these studies is a better understanding of the deep structure of gauge theories and its connection with gravity.

Our group keeps longstanding and very active international collaborations. Among other highlights our group has coordinated two European Networks (FLAVIANET and LHCPHENONET), and the majority of our team are non-Spanish, including PhD students and postdoctoral researchers.

Job position description:
The fellow will develop its own personal research project in collaboration with other members of the research group. A Career Development Plan will be established between the fellow and the supervisor at the start of the fellowship that will include the description of the expected milestones, and attendance to training schools, workshops and international conferences. The fellow will deliver at least one oral presentation per year within the group to monitor the progress of the research project. A secondment to a third institution during at least three months is expected in order to complete the research competences of the fellow and to enhance the transfer-of-knowledge with other researchers.

The fellow is expected to have an advanced understanding of Quantum Field Theory, and a broad capacity of analytic and numerical skills. Basic knowledge of symbolic computational tools, such as Mathematica by Wolfram Research, are an asset. Specific training will be

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completed through a direct mentoring within the group, and attendance to specialized schools. First results are expected to be presented by the fellow at some international conference after the second year.

GROUP LEADER: Germán Rodrigo
german.rodrigo@csic.es
Research project/Research Group website
http://ific.uv.es/lhcpheno

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