Constraining new physics in CMS diboson measurements using effective field theory

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Scientific context

The CMS experiment at the Large Hadron Collider operates at the energy frontier, with a broad research programme searching for evidence of new massive particles predicted in extensions of the standard model (SM). However, if these new states are beyond the direct energy reach of the LHC, a different approach is needed. Using the framework of *effective field theory* (EFT), it is possible to systematically study how new physics leads to deviations from SM predictions in the energy regime accessible. The EFT introduces a set of higher dimensional operators to the SM Lagrangian that parameterise all possible beyond-the-SM interactions. The effects can be small, and necessitate high precision measurements, often with multivariate observables. Processes involving the production of one or more vector bosons, which receive contributions from triple and quartic gauge couplings, are particularly sensitive to several classes of EFT operators.

Internship project

The goal of the project is to study the effect of EFT operators in diboson processes involving W and Z bosons and photons. The student will generate signal events using a Monte Carlo event generator, use reweighting techniques in order to model the EFT effects, and then perform sensitivity studies to identify new observables for CMS data analysis. As a further step, the separation of the EFT signal from the SM backgrounds will be optimized. For this, novel machine learning techniques can be developed, and compared to traditional approaches.

If continuing for a PhD thesis, the studies performed during the internship will be developed into a full CMS analysis of data collected during the current run of the LHC.

Host team at the Laboratoire Leprince-Ringuet

The CMS group at LLR is a founding member of the CMS Collaboration. It has designed, built, and is responsible for the operation of the L1 trigger for the electromagnetic calorimeter (ECAL). It has also designed the calorimeter mechanics and contributed to the front-end readout electronics. It has major involvement in particle reconstruction and identification with the e/gamma and tau Physics Object Groups, and contributed to the development of the Particle Flow event reconstruction. It is among the leading protagonists within the CMS collaboration in diboson, multiboson and Higgs physics, as well as in heavy ions physics.

Other information

This internship is intended for students at the M2 level.