Thesis abstract M. Markovitch

« Study of vector boson scattering and jet noise term measurement with the ATLAS detector »

Vector boson scattering (VBS) processes, which have very low cross sections, allow to probe the structure of the electroweak theory of the Standard Model of particle physics. They are characterized by the presence of two energetic forward jets in opposite hemispheres. This thesis studies VBS processes through electroweak diboson production associated with jets with the ATLAS detector.

In the semileptonic channel, one electroweak boson, W or Z, decays leptonically, to charged leptons or neutrinos, and another one decays hadronically. The hadronic decay can be reconstructed with two small-radius jets (resolved regime) or one large-radius jet (merged regime). This last regime allows to reconstruct high energy bosons. I worked on the statistical analysis of the ATLAS measurement of electroweak diboson production in semileptonic final states using data of the full second data-taking period of the LHC (Run-2), leading to the observation of the process. I also extracted the associated cross sections and contributed to effective field theories interpretation of the results, allowing to parameterize deviations with respect to the Standard Model, setting important constraints on anomalous Quartic Gauge Couplings (aQGCs).

VBS processes are amongst the rare processes sensitive to aQGCs. I performed a statistical combination of ATLAS Run-2 VBS measurements, including the semileptonic channel. Many challenges were overcome, allowing to efficiently combine eight VBS measurements to highly improve aQGC limits and obtain complete two-dimensions limits, taking into account unitarity and positivity constraints. No deviation from the Standard Model is observed.

Jet energy resolution is an important parameter for the analyses using these objects, in particular VBS analyses, all the more in the semileptonic channel. At low transverse momentum, the jet energy resolution is dominated by a noise term, including pile-up noise and electronics noise. The random cones method was developed to extract this noise term specifically. I contributed to the improvement of the method, upgraded it to new ATLAS software releases and applied it to measure the noise term on different jet types for Run-2 and for the beginning of Run-3. I also constributed to the understanding of the limitations of the method.