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J. J. Sakurai Prize: Precision Quantum Chromodynamics at the LHC[1]

DAVID KOSOWER, IPhT, CEA-Saclay

The Large Hadron Collider (LHC) at CERN in Geneva, Switzerland, is the highest-energy particle collider operating today. In 2012, the two general-purpose detector collaborations, ATLAS and CMS, announced the discovery of the long-sought Higgs boson, the last missing particle of the Standard Model. The two collaborations have also set limits on new physics beyond the Standard Model, such as supersymmetry. Future direct and indirect searches for new physics require a precise, quantitative understanding of the known physics of the Standard Model, and in particular of the scattering of quark and gluon constituents of the proton under the strong force, known today as quantum chromodynamics (QCD). Achieving this level of understanding requires at least the incorporation of the first quantum corrections in perturbation theory – next-to-leading order (NLO) corrections – in scattering processes with several constituents leading to several jets in the final state. The new "on-shell" techniques, described earlier by Lance Dixon, have allowed these computations to be made beyond the reach of traditional diagrammatic methods. I will describe a direct numerical application of the new techniques in the BlackHat software library, and several phenomenological studies of physics at the LHC. These include studies relevant to CMS's supersymmetry searches, and to ATLAS measurements of electroweak vector-boson production with up to five associated jets.

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