Quantum algorithms in collider particle physics

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Abstract

We motivate the use of quantum algorithms in particle physics and provide a brief overview of the most recent applications at high-energy colliders. In particular, we discuss in detail how a quantum approach reduces the complexity of jet clustering algorithms, such as anti-kT, in particle collisions and show how quantum algorithms efficiently identify causal configurations of multiloop Feynman diagrams, where each Feynman propagator has been identified with a qubit, and their connection with directed acyclic graphs (DAG) in graph theory. We also present a multivariate quantum integration algorithm, dubbed Quantum Fourier Iterative Amplitude Estimation (QFIAE), which is successfully applied to the evaluation of one-loop Feynman integrals in a quantum simulator or in a real quantum device.

References

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Figures

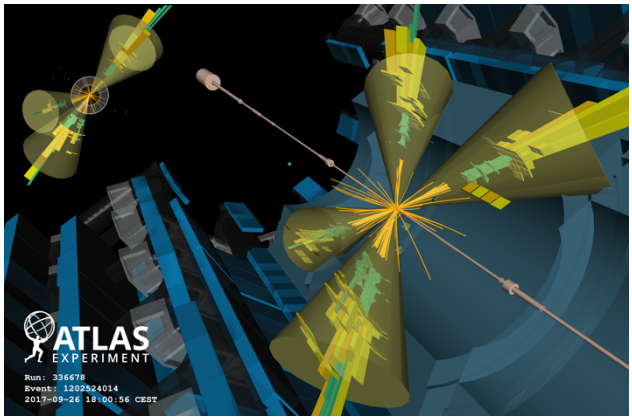

Figure 1: Formation of jets in proton collisions at the CERN´s Large Hadron Collider. Credit: ATLAS Event Displays Repository.

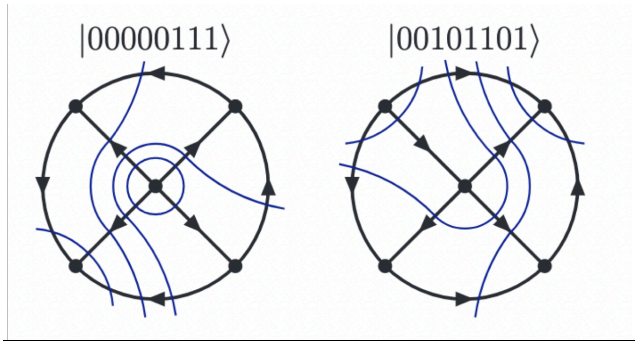

Figure 2: Causal interpretation of a four-loop Feynman diagram from a quantum algorithm.