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Casual query of multiloop Feynman integrals through Grover's algorithm

In the context of high-energy physics, accurate theoretical predictions can be obtained by perturbation theory. However, higher-order contributions require the evaluation of complicated multi-loop Feynman integrals, which is a serious bottleneck in computational frameworks. In this work we present an application of a quantum algorithm to multi-loop Feynman integrals. We introduce a suitable modification of Grover's algorithm to query all causal configurations of the internal propagators of Feynman integrals. Causal representations arise naturally in the loop-tree duality (LTD) framework, and lead to representations of integrals that are numerically more stable than their corresponding Feynman representation. Moreover, causal configurations can also be interpreted in graph theory as acyclic directed graphs.

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