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Flow-oriented perturbation theory

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Abstract

We introduce a new diagrammatic approach to perturbative quantum field theory, which we call flow-oriented perturbation theory (FOPT).
Within it, Feynman graphs are replaced by strongly connected directed graphs (digraphs).
FOPT is a coordinate space analogue of time-ordered perturbation theory and loop-tree duality, but it has the advantage of having combinatorial and canonical Feynman rules, combined with a simplified $i\varepsilon$ dependence of the resulting integrals.
Moreover, we introduce a novel digraph-based representation for the S-matrix.
The associated integrals involve the Fourier transform of the flow polytope. Due to this polytope's properties, our S-matrix representation exhibits manifest infrared singularity factorization on a per-diagram level.
Our findings reveal an interesting interplay between spurious singularities and Fourier transforms of polytopes.

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