Abstract

Title: On-Shell Methods for Tree-Level Amplitudes in (De)Constructed Gauge Theory
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This thesis explores tree-level scattering amplitudes in (De)constructed gauge theories using modern on-shell methods. Traditional Feynman diagram techniques, though systematic, become increasingly cumbersome in theories with gauge redundancies and high multiplicity. Motivated by these limitations, we adopt a framework based on analyticity, factorization, and gauge invariance, applying the BCFW recursion relation and related spinor-helicity techniques.

Our analysis focuses on the two-site model, the simplest (De)constructed scenario, which provides a renormalizable four-dimensional realization of dimensional deconstruction and naturally generates Kaluza-Klein (KK)-like spectra. Tree-level color-ordered amplitudes involving massive and massless vector bosons are computed using the BCFW recursion, revealing significant simplifications and cancellation patterns, especially in longitudinal gauge boson scattering. To access non-MHV sectors, we further employ the Cachazo-Svrček-Witten (CSW) expansion, which efficiently constructs NMHV amplitudes from MHV vertices, offering a complementary perspective to BCFW recursion.

Our results demonstrate that on-shell methods remain powerful even in semi-realistic settings with broken gauge symmetry and massive states. The structural simplicity of the resulting amplitudes suggests potential geometric interpretations and invites extensions to loop-level processes.

Future directions include applying generalized unitarity and BCFW-based recursion at loop level, incorporating double-copy constructions to study gravitational analogues, and exploring formulations via the CHY formalism, scattering forms, or positive geometry such as the amplituhedron. These approaches promise deeper insight into the unifying principles behind quantum field theories and the emergence of higher-dimensional behavior from four-dimensional dynamics.

Keywords: scattering amplitudes, on-shell methods, BCFW recursion, (De)constructed gauge theory