On-Shell Methods for Tree-Level Amplitudes in (De)Constructed Gauge Theory

Application of BCFW Recursion Relation

Su Yingze

Supervisor: Prof. Tanabashi Masaharu

May 29, 2025

Theoretical Particle Physics Laboratory, Nagoya University

Outline

Motivation

Why We Study Scattering Amplitudes?

1. **Bridge between theory and experiment**
    - Core prediction targets for high-energy experiments such as the LHC
    - Any new theory (SUSY, GUTs, extra dimensions) must predict observable cross sections

Why We Study Scattering Amplitudes?

1. **Bridge between theory and experiment**
    - Core prediction targets for high-energy experiments such as the LHC
    - Any new theory (SUSY, GUTs, extra dimensions) must predict observable cross sections
2. **Reveal deep structures of quantum field theory**
    - Amplitudes exhibit hidden symmetries (e.g., dual conformal, Yangian) not visible in the Lagrangian
    - These symmetries suggest deeper theoretical frameworks, such as integrability or AdS/CFT correspondence

Struggles of Traditional Approaches

Model

(De)constructed Gauge Theory

- Based on discretizing extra dimensions
- Multiple gauge groups + link scalar fields
- Focus: a general n-site structure and 2-site limit

Methods

Modern Amplitude Techniques

- BCFW recursion: complex deformation of momenta
- Spinor-helicity formalism: simplifies massless amplitudes
- CSW expansion: handles NMHV amplitudes

Modern Amplitude Techniques

- BCFW recursion: complex deformation of momenta
- Spinor-helicity formalism: simplifies massless amplitudes
- CSW expansion: handles NMHV amplitudes

$$A_n = \sum_{\text{partitions}} \frac{A_L A_R}{P^2}$$

Results

Key Results

- Computed tree-level amplitudes for various helicity configurations
- Verified KK-mode cancellation patterns
- Demonstrated efficiency over traditional Feynman diagrams

Outlook

Future Directions

- Extension to n-site models and loop-level amplitudes
- Application to black hole scattering (on-shell gravity)
- Exploration of geometric frameworks (amplituhedron, CHY)

Acknowledgement

Thanks to my advisor, lab colleagues, and audience!