Generating the Top Quark's Anomalous Magnetic Moment

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Introduction

- Physics to be done during first run of LHC:
  - Ambitious: SUSY, Higgs
  - Guaranteed: Study the top quark
- May be possible to measure anomalous magnetic moment of top
  - Large anomalous magnetic moment = top compositeness
    - Hints of extra dimensions?

Introduction

- To study anomalous magnetic moment, consider most general QED fermion-photon vertex
- Leads to introduction of:

$$\mathcal{L}_a = \frac{a}{2m}\bar{\psi}\Sigma_{\mu\nu}F^{\mu\nu}\psi$$

- New perturbation theory in *a*!
  - No. of Feynman Diagrams ~ $2^n n!$
  - Will use BCFW recursion

BCFW Recursion

- BCFW is an on-shell recursive method

Britto, *et al.*, 2005

- Idea: choose two particles and shift their momenta:

$$\begin{aligned} p_i &\rightarrow p_i - zq \\ p_j &\rightarrow p_j + zq \end{aligned}$$

- To stay on-shell: $q^2 = p_i \cdot q = p_j \cdot q = 0$

BCFW Recursion

- Consider the object:

$$\oint \frac{dz}{z}\mathcal{A}(z)$$

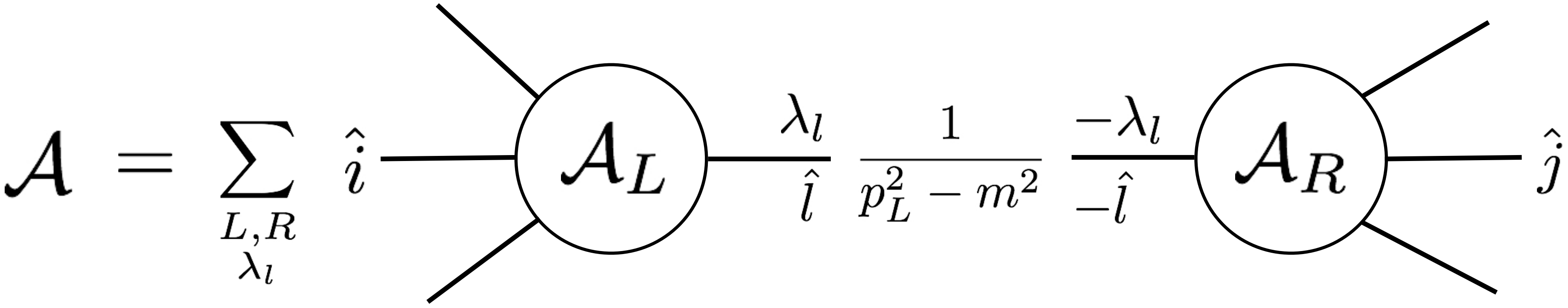
- $\mathcal{A}(0) =$ undeformed amplitude
- If $\mathcal{A}(z) \to 0$ as $z \longrightarrow \infty$:

$$\oint \frac{dz}{z}\mathcal{A}(z) = 0$$

  - Can use Cauchy’s Theorem at tree level!

BCFW Recursion

BCFW Recursion Relation:



BCFW Recursion

- Lore: BCFW recursion works for theories with very good behavior
  - “Need” renormalizability or even finiteness Cachazo, Benincasa, 2007
  - e.g., $N = 4$ supersymmetric theories
- This theory is explicitly non-renormalizable so we naively don’t expect BCFW to work

Computing Amplitudes with BCFW

- If an amplitude has at least one - and one + helicity gluon, use BCFW in fermion theory:

$$\mathcal{L} = \bar{\psi}(i\not{D} - m)\psi + \frac{a}{2m}\bar{\psi}\Sigma_{\mu\nu}F^{\mu\nu}\psi$$

- If amplitude has only + or - helicity gluons use BCFW in scalar theory:

$$\mathcal{L} = \frac{1}{m}\bar{\psi}\left[-D^2 - m^2 + \frac{g}{2}\Sigma_{\mu\nu}F^{\mu\nu}\right]\psi$$