Cluster Polylogarithms Gameplan July 20, 2017

Goal: closed-form representation of n-particle, two-loop MHV amplitude in N=4 SYM.

Fall-back goal: 8-particle, two-loop MHV amplitude.

Individual steps

- Generate subalgebras of finite cluster algebras: $A_2, A_3, A_4, D_4, A_5, D_5, E_6$.
- Apply f_{A_2} and f_{A_3} across subalgebras, cataloguing identities etc.
- Find larger subalgebras with "unique" functions by applying analytic and/or algebraic criteria such as:
  - collinear limits
  - branch cuts (first-entry, Steinmann)
  - Poisson bracket structure
- Related, find "completions" (products of lower weight functions) for f_{A_2} and f_{A_3} by considering similar criteria.
- Build 7- and 8-pt amplitudes out of new larger subalgebra functions, hopefully in a fully unique way. (Can build 8-pt amplitude out of pre-existing functions, so this is the fall-back paper.)
- Use 7- and 8-pt amplitude structure as guide for constructing closed-form representation of n-particle, two-loop MHV amplitude.

Other Opportunities

- Higher-weight cluster polylogarithms (test Goncharov hypothesis, try to re-write 6-pt 3-loop in terms of cluster functions, etc).
- Re-write known non-MHV results in cluster algebra language.
- New functional relations for Li_4 (and higher?) of cluster algebraic origin.
- Understand larger connections between Feynman diagram integrals and cluster algebra polylogarithms.