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# Greetings from Beijing

ERC miniworkshop
27 January 2012

Contents

## Calculate Feynman Diagrams Efficiently

### Tree-Level:

- ⋆ Feynman-diagram based method.
- ⋆ Recursion relations:
  Off-shell (Berends-Giele,Dyson-Schwinger),
  On-shell (BCFW).

### One-Loop Reductions:

- ⋆ Passarino-Veltman reduction.
- ⋆ Integration by parts (e.g. hep-ph/0303184).
- ⋆ Unitarity-based method (On-shell,e.g. OPP).
- ⋆ Other numerical approaches.

### Multi-Loop Reductions:

- ⋆ Integration by parts (e.g. Laporta's algorithm)
- ⋆ Sector decomposition (numerical).
- ⋆ Unitarity-based method (e.g. first attempts in 1107.6041).

Our work

1) Rational Terms [1].
2) One-Loop Reductions in Cutoff Regularization [2].

[1] "**Feynman Rules for the Rational Part of the Standard Model One-loop Amplitudes in the 't Hooft-Veltman $\gamma_5$ Scheme**"
**H. S. Shao**, Y. J. Zhang and K. T. Chao
JHEP **09** (2011) 048, [arXiv:1106.5030 [hep-ph]].
[2] "**Reduction Schemes in Cutoff Regularization and Higgs Decay into Two Photons** "
**H. S. Shao**, Y. J. Zhang and K. T. Chao
JHEP **01** (2012) 053, [arXiv:1110.6925 [hep-ph]].

Some worthy of concerned aspects

1. Automation of NLO calculations in QCD (achieved by MadLoop and HELAC-NLO), EW and any (gauge) theory (one of primary goals in our ERC project).
2. Systematic and analytic computations of physical observables (e.g. in unitary-based methods).
3. Generalizations of on-shell approaches to multi-loop and constructions of universal infrared substraction terms to high-order (beyond NLO) level.
4. Applications of on-shell methods and universal infrared substraction terms to some special effective field theories (e.g. non-relativistic QCD).

How to understand the production mechanisms of heavy quarkonium?

1. Color-singlet model.
2. Color evaporation model and quark-hadron duality.
3. Non-relativistic QCD factorization.
4. Fragmentation functions.

Several difficulties in understanding of $J/\psi$ production at hadron colliders

1. The surplus production of $J/\psi$ measured by CDF.
2. The polarization of $J/\psi$ at the Tevatron (our recent work [3]).
3. The production of $J/\psi$ at the low transverse momentum.

[3] "$J/\psi$ **polarization at hadron colliders in nonrelativistic QCD**"
K. T. Chao, Y. Q. Ma, **H. S. Shao**, K. Wang and Y. J. Zhang
arXiv:1201.2627 [hep-ph].

Some interesting anomalies

1) The forward backward asymmetry of top quark production at the Tevatron.
2) The dijet anomaly production associated with W boson measured by CDF.
3) The forward backward asymmetry of bottom quark production at the LEP.
4) The recent updated Higgs search results by ATLAS and CMS.

# Thanks for your attentions!