The LHE Accord:

A Bridge Between Different Theory Communities

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Two Approaches to νA Interactions

I. Right nuclear physics is essential: Must simulate νA interactions from the start

- ★ accurate lepton-side predictions
- ★ hadron-side un- or under-specified
- ★ calculations are hard and not always for the desired nucleus
- ★ many analyses need predictions of exclusive final states
- ★ not many free parameters to fit/tune to data

II. Can simulate νn interactions and build up νA interaction

- ★ universality of n form factors
- ★ assumption of some factorization of different effects
- ★ nuclear physics: coupling between nucleons is weak enough and can be corrected for
- ★ many exclusive final states
- ★ many free parameters to tune to data

Correspondence to Collider Physics

I. == NLO calculations, possibly resummed, for W boson p_T and/or high-multiplicity tree-level predictions for $W + n$ partons

II. == "universal" event generators (EGs) centered on $2 \to 2$ QCD cross section formulae

I. parton + parton $\to$ partons in powers of $\alpha_s^n(Q)$

II. injection of configurations into EG to:

1. include $\alpha_s^m(p_T) \log^l(p_T)$ physics
2. treatment of remnant, hadronization, complete event

★ In many cases, I + II is not trivial – not simply an addition of effects and requires an intelligently-designed interface

I + II Methodology

A. Accord or agreement between I-types and II-types on what information needs to be provided

- ⋆ Originally formatted text
- ⋆ XML + formatted text
- ⋆ HDF5/table-based format

B. Removal of double-counting

- ⋆ original partons vs. shower generated partons
- ⋆ EG vetos event configurations covered elsewhere
  e.g. W + 4 partons vs. W + 3 partons + parton shower
- ⋆ I-type calculations regulated (cut-off) in a particular way and interpolated onto II-type effects

I + II Methodology (cont)

C. Treatment of negative weights

- ⋆ cancellation of negative and positive contributions of NLO calculations are preserved
- ⋆ I-type calculation adapted to perform subtractions “differently”
- ⋆ II-type calculations add on shower in a special way to preserve kinematics

B. was rather easy to develop. C. took a longer.
All happened because of A.

Both I-types and II-types had to make changes.

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The Path was not straight and flat

Premature optimization is the root of all evil – D. Knuth

May 2001, Les Houches (my memory)

After a full day of discussions in the library at Les Houches, most of us were spent after dealing with difficult colleagues and the details of the interface. However, that night, Torbjorn put together a prototype and, by the next day, the Alpgen people (MLM) were trying it out. Suddenly, everyone else was scrambling to catch up.

It is a prime example of positive stubbornness beating negative stubbornness.

Evolution

Format has changed with improved theory calculations

(No one knows the momenta of incoming partons – such situations are not unique to neutrino physics)

External weights per event:

- ⋆ parton distribution groups provide either replicas or eigen vectors to represent uncertainties.
- ⋆ $\sim$ 100 weights for a given pair of incoming partons

NLO uncertainties

- ⋆ calculations provide weights of factorization and renormalization scale variations

EG interface

- ⋆ Energy scales are provided to indicate the starting scale for parton showers to control double-counting

Concluding Remarks

- ⋆ interface of advanced theory calculations and event generators is neither trivial nor unattainable
- ⋆ common language between communities is necessary
- ⋆ understanding of the overlap between different physics effects is necessary – public user hooks are needed to implement this
- ⋆ My experience: whoever does this first will drive everyone else