Monte Carlo Generators for New Physics and Studies at NLO

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Physics prelims

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- WE DO NOT KNOW WHAT TO EXPECT

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A Strategy

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  $\Rightarrow$ (N)NLO Calculations/Codes are necessary

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- Identify classes of BSM Models compatible with the excesses
- Look for predicted consequences (e.g. excesses) in other channels
  $\Rightarrow$ Fast BSM MC tools are necessary
- Refine the analysis
  $\Rightarrow$ More sophysticated BSM MC tools are necessary

Physics prelims

Ongoing activity

MC4BSM workshops (`http://theory.fnal.gov/mc4bsm/`):

- 4th workshop: APRIL 3-4, 2009 (UC DAVIS)
- 3rd workshop: MARCH 10-11, 2008 (CERN)
- 2nd workshop: MARCH 21-24, 2007 (PRINCETON)
- 1st workshop: MARCH 20-21, 2006 (FERMILAB)

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Available tools

  - MARMOSET (N. Arkani-Hamed *at al.* http://marmoset-mc.net/Marmoset/Marmoset.html)

  - AlpOSET (ALPGEN + M. Treccani http://mlm.home.cern.ch/mlm/alpgen/)

BSM MCs *(I)*

Program	
PHTHIA	http://home.thep.lu.se/ torbjorn/Pythia.html
HERWIG++	http://hepwww.rl.ac.uk/theory/seymour/herwig/
SHERPA	http://projects.hepforge.org/sherpa /dokuwiki/documentation/index
MADGRAPH	http://madgraph.hep.uiuc.edu/
COMPHEP	http://comphep.sinp.msu.ru/
FeynRules	http://europa.fyma.ucl.ac.be/feynrules
ALPGEN	http://mlm.home.cern.ch/mlm/alpgen/

BSM MCs *(II)*

Program	Susy	Extra Dim.	Bosons′	Other Models
PHTHIA	x	x	x	LR Symmetry
HERWIG++	x	-	x	-
SHERPA	x	x	-	User defined
MADGRAPH	x	-	-	2HDM
COMPHEP	x	x	x	2HDM
FeynRules	-	-	-	User defined
ALPGEN	-	-	x	Heavy N

NLO Codes

Programs based on Feynman-Diagrams *(small n. of legs)*:

- MCFM (Campbell, Ellis, http://mcfm.fnal.gov/)

Programs based on Recursion Relations *(large n. of legs)*:

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- HELAC/CutTools (van Hameren, Papadopoulos, Pittau)

The OPP Method (in a nutshell)

$$\mathcal{A} = \sum_{I \subset \{0,1,\ldots,n-1\}} \int \frac{\mu^{4-d} d^d \bar{q}}{(2\pi)^d} \frac{\bar{N}_I(\bar{q})}{\prod_{i \in I} \bar{D}_i(\bar{q})}$$

$$\begin{aligned} \mathcal{A} &= \sum_i d_i \ \mathrm{Box}_i + \sum_i c_i \ \mathrm{Triangle}_i + \sum_i b_i \ \mathrm{Bubble}_i \\ &+ \sum_i a_i \ \mathrm{Tadpole}_i + R \end{aligned}$$

The OPP Method (in a nutshell)

$$
\begin{aligned}
N(q) &= \sum_{i_0<i_1<i_2<i_3}^{m-1} \left[d(i_0 i_1 i_2 i_3) + \tilde{d}(q; i_0 i_1 i_2 i_3) \right] \prod_{i \neq i_0, i_1, i_2, i_3}^{m-1} D_i \\
&+ \sum_{i_0<i_1<i_2}^{m-1} \left[c(i_0 i_1 i_2) + \tilde{c}(q; i_0 i_1 i_2) \right] \prod_{i \neq i_0, i_1, i_2}^{m-1} D_i \\
&+ \sum_{i_0<i_1}^{m-1} \left[b(i_0 i_1) + \tilde{b}(q; i_0 i_1) \right] \prod_{i \neq i_0, i_1}^{m-1} D_i \\
&+ \sum_{i_0}^{m-1} \left[a(i_0) + \tilde{a}(q; i_0) \right] \prod_{i \neq i_0}^{m-1} D_i \\
&+ \tilde{P}(q) \prod_{i}^{m-1} D_i
\end{aligned}
$$

As a result...

The virtual parts of all processes containead in the so called *2007 Les Houches wish list* have been recently computed:

van Hameren, Papadopoulos, Pittau, e-Print: arXiv:0903.4665 [hep-ph]

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- Thanks for your attention!