Monte Carlo Event Generators

Peter Richardson
(CERN, TH)

- Introduction
- ISAJET
- SUSYGEN
- NLO
- Others

Introduction

- Most studies of BSM physics rely on the general purpose event generators for simulation.
- This talk is to briefly review the codes for which there won't be separate presentations.

Monte Carlo Event Generators

- There are many SUSY event generators available.
- These event generators fall into two classes.
- General Purpose Event Generators
  - These programs were written for SM simulation but have been extended to include SUSY simulation.
  - There are three generators ISAJET, PYTHIA, HERWIG.
- BSM Generators
  - These generators usually only handle the hard production and decay of the SUSY particles.
  - Usually they are interfaced to one of the general purpose event generators for the parton shower and hadronization phases.
  - Examples include SUSYGEN, Black Hole Generators.

ISAJET

- ISAJET is the oldest of the BSM generators.
- Available from
  - http://paige.home.cern.ch/paige/
- Uses the original parton shower algorithm which only resum collinear logarithms.
- Uses the original independent fragmentation model of Feynman and Field.
- ISAJET is known to give a poor description of Standard Model processes.

SUSY in ISAJET

- There is a built in RGE code with a large number of SUSY models.
- Calculation of the SUSY decay rates.
- Includes decay matrix elements for the SUSY decays.
- Has beam polarization effects in lepton collisions, but no spin correlations.
- R-parity violation can only be added by hand.

Other Models in ISAJET

- Includes the technirho of Tecnicolour models.
- Includes graviton + a standard model particle as in large extra dimension models.

SUSYGEN

- Originally for the simulation of SUSY at LEP.
- Only simulates hard process and SUSY decays.
- Interfaced to PYTHIA for parton shower and hadronization.
- Now simulates lepton-lepton, lepton-hadron and hadron-hadron collisions.
- Includes RGE code.
- Polarization and spin correlations in lepton collisions.
- R-parity violation implemented
- Calculation of decay rates.
- Available from
  - http://lyoinfo.in2p3.fr/susygen/susygen3.html

NLO Cross Section Calculations

- There are a number of programs which calculate next-to-leading order cross sections.

- The major programs are
  - PROSPINO for squark/gluino production in hadron collisions.
  - Various NLO Higgs production calculations
  - These are available from http://mspira.home.cern.ch/mspira/proglist.html

- Many other SUSY NLO calculations have been done.

- Some of these may be available.

- As always it would be helpful if more were available.

Automatic Matrix Element Generators

- There are also programs available which automatically calculate matrix elements.
- Some of these include BSM physics, or will do soon
  - COMPHEP
    - Automatic calculation of cross sections using trace techniques.
    - Phase Space integration by VEGAS.
  - AMEGIC++
    - Automatic calculation of cross sections using helicity amplitudes.
    - Phase Space integration using automatic multi-channel techniques.
  - MadGraph
    - Calculation of matrix elements using helicity techniques.
    - Phase Space integration using automatic multi-channel techniques.
  - GRACE
    - Calculation of matrix elements using helicity techniques.
    - Performs the phase-space integration using BASES.

Other Programs

- There are a number of programs for the hard process around.
- Few of these are publicly available.
- Some on request from the authors.
- The main programs in the class are for black hole generation
  - Truenoir by Landsberg et. al
  - Black Hole Generator by Harris, Richardson, Webber
- Probably others I'm not aware of.