Main facilities of CompHEP

CompHEP is a package for automatic calculations of elementary particle decays and collision processes in the lowest order of perturbation theory (the tree level approximation). The main idea behind the program is to make calculations and data manipulations from Lagrangians to final distributions with a high level of automation. There are several packages created to solve the problem in a similar way: FeynArts/FeynCalc, GRACE, HELAS, MadGraph. CompHEP is a GUI computer system with context help. A user makes all manupulations by means of graphical menus.

The notations used in CompHEP are very similar to those used in particle physics.

CompHEP is based on an idea of the physical model. ComHEP Models are very simular to physical models in high energy physics, like Standards Model or MSSM. The present version of the program has several built-in physical models (see later). Two of them are versions of the Standard Model (SU(3)xSU(2)xU(1)) in the unitary and t'Hooft - Feynman gauges. Users can change particle content of a model, interaction vertices, and other model parameters. It is also possible to create a new model of particle interaction.

The present version does not take into account separate polarization states of particles. All results are presented with averaged initial and summed final polarization states.

The CompHEP package consists of two parts, symbolic and numerical programs. The symbolic part is written in the C programming language. It produces C codes for squared matrix elements, and they are used in the numerical calculation later on.

The symbolic part of CompHEP has the following possibilities:

- select a process by specifying incoming and outgoing particles for the decays of $1 \rightarrow 2, \ldots ,1 \rightarrow 5$ types and the collisions of $2 \rightarrow 2, \ldots , 2 \rightarrow 6$ types;
- generate Feynman diagrams, display them, and create the corresponding LATEX output;
- exclude some diagrams;
- generate and display squared Feynman diagrams;
- calculate analytical expressions corresponding to squared diagrams by using the fast built-in symbolic calculator;
- save symbolic results corresponding to the squared diagrams calculated in the Reduce and Mathematica codes for further symbolic manipulations;
- generate the optimized C codes for the squared matrix elements for further numerical calculations;
- launch the make program in order to prepare the numerical part;

The numerical part of CompHEP offers to:

- convolute the squared matrix element with structure functions and beam spectra: built-in CTEQ and LHAPDF parton distribution functions, the ISR and Beamstrahlung spectra of electrons, the laser photon spectrum, and the Weizsaecker-Williams photon structure functions are available;
- modify physical parameters (total energy, charges, particle masses, charges, etc.) involved in the process;
- select an evaluation scale for the QCD coupling constant and parton structure functions;
- introduce various kinematic cuts. Some cuts are built in and there is a special code to define more involved cuts;

- define a kinematic scheme (a phase space parameterization) for effective Monte Carlo integration;
- introduce a phase space mapping in order to smooth sharp peaks of squared matrix elements and structure functions;
- perform Monte-Carlo phase space integration by Vegas;
- generate events;
- display distributions of various kinematic variables;
- create graphical and LATEX outputs for the histograms.

CompHEP Models.

The default set of models included to CompHEP consists of

- QED
- Effective 4 fermion (Fermi Model)
- Standard Model in unitary gauge
- Standard Model in Feynman gauge
- MSSM in unitary gauge
- MSSM in Feynman gauge
- SUGRA in unitary gauge
- GMSB in unitary gauge
- Standard Model, with 2 quark generations unified (see more details in the paper)
- QCD with 4 quarks unified (see more details in the paper)

See here more details about MSSM models.

LanHEP overview

The LanHEP program for Feynman rules generation in momentum representation is presented. It reads the Lagrangian written in the compact form close to one used in publications. It means that Lagrangian terms can be written with summation over indices of broken symmetries and using special symbols for complicated expressions, such as covariant derivative and strength tensor for gauge fields. The output is Feynman rules in terms of physical fields and independent parameters. This output can be written in LaTeX format and in the form of CompHEP model files, which allows one to start calculations of processes in the new physical model. Although this job is rather straightforward and can be done manually, it requires careful calculations and in the modern theories with many particles and vertices can lead to errors and misprints. The program allows one to introduce into CompHEP new gauge theories as well as various anomalous terms.

More details see LanHEP home page

CompHEP-Pythia interface

cpyth is a special package to process events prepared by CompHEP in PYTHIA. The last version of the package is available on the download page of the site.