Progress in FDC Project
Jian-Xiong Wang
Institute of High Energy Physics, Academia Sinica
P. O. Box 918, Beijing 100039, China


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1  Brief Introduction to FDC(Feynman Diagram Calculation)

Standard Model and its extension, Feynman diagram generator,
some one-loop manipulation
---- developed in 1993 and presented in AIHENP93, Germany

Feynman diagram drawer ---- completed in 1994

Tree Processes amplitude manipulation and FORTRAN source generation
---- completed in 1995 and more optimized method was introduced later

Automatic Kinematics treatment ---- developed in 1997 and presented in AIHENP97, Switzerland

Muti-processes Generation ---- developed in 1996,97,98 presented in 1st ACAF workshop
in Beijing, 1998

MSSM ------- realized in 1999
Supersymmetry model with R-parity vilation ------- realized in 2000

For partial wave analysis method: Phenomenology model, Amplitude manipulation
when High Spin state (3/2, 2, 5/2, 3 ... ) included and Likelihood fitting
for experiment data ------ introduced in 1999 and 2000

Effective Meson Theory(Bin-An Li’s): Feynman rules deduction and amplitude calculation
------ introduced in 2001 and 2002

NRQCD method: Effective model and amplitude calculation ------ introduced in 1997 and 2003

Many other options, functions were introduced during 1993-now
Input For Physical Model

Physical Model Evaluation

Full Feynman Rules
Counterterms
Physical parameters

Latex Version of The Model

Input For Physical Process
Chose Physical Model and Process

Generation of Feynman Diagram
Amplitude Manipulation
Treatment of Kinematics
Numerical Integration

Numerical Results
Required plots in Hbook format

Physical parameters

Counterterms

Full Feynman Rules

Physical Model Evaluation

Input For Physical Model
To construct the Lagrangian according to the following conditions:

Gauge Invariance, Global Symmetry, Supersymmetry, Yukawa Coupling, $H^+ = H$,

and then to deduce Feynman rules, Mixing of particles, ......
To Construct All The Possible Interaction Vertices From All The Particles By Applying The Following Conditions:

\[ H^+ = H, \] Lorentz Invariance, CP Invariance, P Invariance,

C Invariance, Isospin Conservation,

Baryon Number Conservation, ......
To generate Feynman Diagram

To manipulate amplitude for each diagram and generate Fortran source for amplitude and amplitude square calculation (Three method to calculate amplitude square, up to 6 final state processes have been calculated.)

To find and properly treat all the resonance, t-channel singularity, and generate phase space integration Fortran source

To compile all the Fortran source and run "int" to get total cross section and required plots, correlation quantity, ....
To generate Feynman Diagram

To manipulate amplitude for each diagram and generate Fortran source for amplitude and amplitude square calculation. Fortran source to do Likelihood fitting for all the free parameters which were introduced in physical model.

To find and properly treat all the resonance, t-channel singularity, .... and generate phase space integration Fortran source.

Control flag and parameters files generated by FDC, Which can be changed by user: flag.inp, amptable.inp, fpara.inp, reson.inp

User prepare two Files: pdata1.dat — Experiment event data file, pdata1.mc — Phase space Moto Calo Event file

To make the Fortran programs and run "fit" to Likelihood fitting.

Output: mplot.info, pep.res, mplot.hbook, dplot.hbook
2 Supersymmetry model

There are five parts in FDC project to work together to calculate Feynman Diagram. One of them is to construct Lagrangian and deduce Feynman Rule automatically. We have added super-symmetry model to FDC in 1999. From a very simple and easy understanding input, it can construct Lagrangian, deduce all mixing matrices, all Feynman rules and then prepare the Latex version of the result and internal version for later using in FDC. A parameterization scheme can be chose under some interface with user and the Fortran source is prepared to calculate the deduced parameters which are needed in following calculation. It is very easy to add more leptons, more Higgs, ..., to break global symmetry such as lepton number conservation, baryon number conservation in the input file. It was used to generate MSSM, and super-symmetry model with different R-parity violation.

3 Effective Lagrangian Model

For partial wave analysis method:

Phenomenology model Amplitude manipulation when High Spin state (3/2, 2, 5/2, 3 ... ) included and Likelihood fitting for experiment data It is using for BES experiment analysis.

4 Muti-Processes Generation

\[
\begin{align*}
  e^+ e^- & \rightarrow 2, 3, 4 \text{ final particles} \\
  e^- p & \rightarrow 2, 3, 4 \text{ final particles} \\
  p p & \rightarrow 2, 3, 4 \text{ final particles} \\
  e^+ e^- & \rightarrow J/\psi + 1, 2, 3
\end{align*}
\]

5 Summary

To deal with very complicate model like supersymmetry model, there are lengthy deduce have be done. to automatic construct Lagrangian and deduce Feynman rules have obviously advantages.

Easy to change many thing:

- contents of particles
- gauge fix terms
- notation
- softbreaking terms
- super potential

More Easy to check and control mistake