

FeynRules - Installation instructions

The aim of this session is to make the user familiar with the basics of FeynRules on the example of the Standard Model included in the distribution. FeynRules can be downloaded from <http://feynrules.irmp.ucl.ac.be>. You need to have Mathematica installed on your machine in order to run FeynRules. Simply download the package and untar it.

Next, you can have a look at the SM implementation, contained in the directory `/feynrules-current/models/SM/`. This folder contains various files, but in this introductory session we will only look at two of them:

1. `SM.fr`: the model file (a text file) containing the implementation of the SM in FeynRules.
2. `SM.nb`: a Mathematica notebook, showing how to load and run the model to obtain the Feynman rules.

1 The FeynRules model file

Open the model file for the SM, `SM.fr`, in a text editor. In the following we give a very brief account on the general structure of a FeynRules model file. During the tutorial, you will be given the opportunity to write your own FeynRules model file, and we therefore limit ourselves at this stage to describe the generic features.

A generic FeynRules model file contains four parts:

1. A list called `M$GaugeGroups` containing the definitions of all the gauge groups of the model.
2. A list called `M$Parameters` containing the definitions of all the parameters of the model.
3. A list called `M$ClassesDeclarations` containing the definitions of all the fields of the model. Note that the fields are grouped into classes of particles carrying the same quantum numbers.
4. The Lagrangian of the model, written in Mathematica form.

2 The sample notebook

Next, open the notebook `SM.nb`. The first few lines of the notebook show how to load FeynRules into Mathematica,

```
$FeynRulesPath = SetDirectory["< address of the package >"]
```

```
<< FeynRules`
```

```
SetDirectory[$FeynRulesPath <> "/Models/SM"];
```

The first line sets the path to the FeynRules main directory. Note that `< address of the package >` should be replaced by the path of the FeynRules main directory on your computer. For example, if the FeynRules main directory is in your home folder, then the first line should read

```
$FeynRulesPath = SetDirectory["~/feynrules-current"]
```

The second line loads the FeynRules package. If successful, an output is printed on the screen. The third line changes the path to the subfolder `Models/SM` that contains the SM implementation.

After FeynRules has been successfully loaded into Mathematica, the SM implementation can be loaded by issuing the command

```
LoadModel["SM.fr"]
```

The next command is optional, and loads some additional files that put the masses of the first two generations of fermions to zero, and restricts the CKM matrix to be diagonal. As this step is optional, we will not describe it any further.

The first section of the notebook, *The SM Lagrangian*, shows the Lagrangian that is implemented in `SM.fr`. Note that the SM implementation of FeynRules is available in both Feynman and unitary gauge. The boolean variable `FeynmanGauge` allows to switch between the two gauges. The second section shows how one can use some built-in functions to perform some basic checks on the Lagrangian, *e.g.*, to check if the Lagrangian is hermitian. The last two sections illustrate how to compute the Feynman rules of the model with FeynRules, and how to use the interfaces to the Feynman diagram generators.