Contribution 2

Further developments in the Flavour Les Houches Accord

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Abstract

The Flavour Les Houches Accord (FLHA) specifies a standard set of conventions for flavour-related parameters and observables such as Wilson coefficients, form factors, decay tables, etc, using the generic SUSY Les Houches Accord (SLHA) file structure. The accord provides a model-independent interface between codes evaluating and/or using flavour-related observables.

We present here a few clarifications and improvements to the accord. In addition, we provide instructions for a new block concerning the electric and magnetic dipole moments.

1 INTRODUCTION

The FLHA [17] exploits the existing organisational structure of SLHA [15, 16] and defines an accord for the exchange of flavour related quantities. In brief, the purpose of this accord is to present a set of generic definitions for an input/output file structure which provides a universal framework for interfacing flavour-related programs. Furthermore, the standardised format provides the users with clear and well-structured results.

The FLHA project has started in Les Houches 2009 where a first proposal was prepared [42]. This proposal was further completed in the form of an official and published write-up in [17]. FLHA is fully compatible with SLHA and can contain the SLHA blocks relevant for flavour physics such as `SMINPUTS`, `VCKMIN`, `UPMNSIN`, `VCKM`, `IMVCKM`, `UPMNS`, `IMUPMNS` and `MODSEL`. The FLHA specific block names start with “F” in order to emphasise their belonging to FLHA. The blocks which are already defined include: `FCINFO`, `FMODSEL`, `FMASS`, `FLIFE`, `FCONST`, `FCONSTRATIO`, `FBAG`, `FWCOEF`, `IMFWCOEF`, `FOBS`, `FOBSERR`, `FOBSSM` and `FPARAM`.

In the following, we provide more details about the definition of the meson mixings in `BLOCK FOBS` and introduce `BLOCK FDIPOLE` for the electric and magnetic dipole moments.

2 MESON MIXINGS

Meson mixing is assigned observable type 7 in `BLOCK FOBS`. In the FLHA, we assume the standard definition for the meson mixings. The oscillation frequency of Q_q^0 and $\bar{Q}_q^0$ mixing is characterised by the mass difference of the heavy and light mass eigenstates [43]:

$$\Delta M_q \equiv M_{\rm H}^q - M_{\rm L}^q = 2{\rm Re}\sqrt{(M_{12}^q - \frac{i}{2}\Gamma_{12}^q)(M_{12}^{q*} - \frac{i}{2}\Gamma_{12}^{q*})}, \tag{1}$$

where M_{12} and Γ_{12} are the transition matrix elements from virtual and physical intermediate states respectively. For the kaon systems this gives:

$$\Delta M_K = 2\mathrm{Re}\, M_{12}. \tag{2}$$

In the case of $\Delta B = 2$ transitions since $|\Gamma_{12}| \ll |M_{12}|$, one can write:

$$\langle B_q^0|\mathcal{H}_{\rm eff}^{\Delta B=2}|\bar{B}_q^0\rangle = 2M_{B_q}M_{12}^q\,, \tag{3}$$

where M_{B_q} is the mass of B_q meson and

$$\Delta M_q = 2|M_{12}^q|. \tag{4}$$

The quantity given in the block is ΔM_q and the unit is fixed to 1/ps. We use the PDG number of the oscillating mesons for the parent and the flipped sign for the daughter.[1] The number of daughters is fixed to 1. For example, the $B_s - \bar{B}_s$ oscillation frequency is given as:

```
Block FOBS  # Flavour observables
# ParentPDG type  value      q        NDA  ID1  ID2  ID3 ... comment
   531      7     1.9e01     0        1    -531 # Delta M_s
```

Similarly, the corresponding SM values and the errors can be given in `BLOCK FOBSSM` and `BLOCK FOBSERR`, respectively. Note that the matrix elements (which are not physical observables) cannot be given in this block. Such quantities can be expressed in terms of Wilson coefficients, decay constants, bag parameters, etc. which are defined in the FLHA, or they can be given in a user defined block.

3 DIPOLE MOMENTS

We define `BLOCK FDIPOLE` which contains the electric and magnetic dipole moments. The standard for each line in the block should correspond to the FORTRAN format

```
(1x,I10,3x,I1,3x,I1,3x,1P,E16.8,0P,3x,'#',1x,A),
```

where the first ten-digit integer should be the PDG code of a particle, the second integer the type (electric or magnetic), the next integer the model (SM, NP or SM+NP, as in `FWCOEF`) and finally the last double precision number the value of the moment. The electric dipole moments must be given in e.cm unit.

The PDG codes for the nuclei follows the PDG particle numbering scheme [44]: "Nuclear codes are given as 10-digit numbers $\pm 10LZZZAAAI$. For a (hyper)nucleus consisting of n_p protons, n_n neutrons and n_Λ Λ's, $A = n_p + n_n + n_\Lambda$ gives the total baryon number, $Z = n_p$ the total charge and $L = n_\Lambda$ the total number of strange quarks. I gives the isomer level, with $I = 0$ corresponding to the ground state ... To avoid ambiguities, nuclear codes should not be applied to a single hadron, like p, n or Λ^0, where quark-contents-based codes already exist." As an example, the PDG code of the deuteron is 1000010020.

The types of the moments are defined as follows:

[1]Exceptions to this rule are possible, for instance, in the case of K-$\bar{K}$ mixing, where the states $K_{\rm long}$ and $K_{\rm short}$ with their PDG numbers 130 and 310, respectively, can be used.

`1` : electric

`2` : magnetic

The electric and magnetic moments can be given for the SM only, the New Physics (NP) only or the total contributions of both SM and NP, using the following definitions:

`0` : SM

`1` : NP

`2` : SM+NP

For example the muon anomalous magnetic moment can be given as:

```
Block FDIPOLE  # Electric and Magnetic dipole moments
# PDG_code type  M    value           comment
    13     2     1    3.02e-09  # 1/2 (g-2)_mu
```

CONCLUSIONS

The Flavour Les Houches Accord is a helpful tool for interfacing flavour physics and high p_T physics codes in order to exploit maximal information from both collider and flavour data. We presented here a few clarifications and improvements viz. the published write-up [17]. The FLHA will continue to improve as the number of codes and interfaces grows in order to accommodate the specific needs of the relevant programs.