Flavor Les Houches Accord (FLHA)

Second meeting

To be discussed:

- The blocks in the second proposal
- Operator basis for the Wilson coefficients
- Labelings
- Suggestions for new blocks
- Any other comment?
- Defining the tasks

Wilson coefficients

$b \to s \gamma$ transitions:

8+8 operators: $O_1 \ldots O_8$ + prime operators (with L ↔ R exchange)

Problem: 2 bases

- Standard (Misiak et al.)
- Traditional (Buras et al.)

$b \to s l^+ l^-$ transitions:

O_9 & O_{10} + prime operators

O_S & O_P for annihilation processes

$b \leftrightarrow s$ oscillations:

Q^{VLL}, Q^{VRR}, Q_1^{LR}, Q_2^{LR}, Q_1^{SLL}, Q_2^{SLL}, Q_1^{SRR}, Q_2^{SRR}

Vector, scalar and tensor operators...

Others?

Operators

b→s γ transitions:

8+8 operators: O_1 … O_8 + prime operators (with L ↔ R exchange)

•Problem: 2 bases linearly dependent

Standard (Misiak et al.)

$$
\begin{aligned}
O_1 &= (\bar{s}\gamma_\mu T^a P_L c)(\bar{c}\gamma^\mu T^a P_L b)\,, \\
O_2 &= (\bar{s}\gamma_\mu P_L c)(\bar{c}\gamma^\mu P_L b)\,, \\
O_3 &= (\bar{s}\gamma_\mu P_L b)\sum_q (\bar{q}\gamma^\mu q)\,, \\
O_4 &= (\bar{s}\gamma_\mu T^a P_L b)\sum_q (\bar{q}\gamma^\mu T^a q)\,, \\
O_5 &= (\bar{s}\gamma_{\mu_1}\gamma_{\mu_2}\gamma_{\mu_3} P_L b)\sum_q (\bar{q}\gamma^{\mu_1}\gamma^{\mu_2}\gamma^{\mu_3} q)\,, \\
O_6 &= (\bar{s}\gamma_{\mu_1}\gamma_{\mu_2}\gamma_{\mu_3} T^a P_L b)\sum_q (\bar{q}\gamma^{\mu_1}\gamma^{\mu_2}\gamma^{\mu_3} T^a q)\,, \\
O_7 &= \frac{e}{16\pi^2}\,[\bar{s}\sigma^{\mu\nu}(m_s P_L + m_b P_R) b]\, F_{\mu\nu}\,, \\
O_8 &= \frac{g}{16\pi^2}\,[\bar{s}\sigma^{\mu\nu}(m_s P_L + m_b P_R) T^a b]\, G^a_{\mu\nu}\,,
\end{aligned}
$$

Traditional (Buras et al.)

$$
\begin{aligned}
P_1 &= (\bar{s}_L^\alpha \gamma_\mu c_L^\beta)(\bar{c}_L^\beta \gamma^\mu b_L^\alpha)\,, \\
P_2 &= (\bar{s}_L^\alpha \gamma_\mu c_L^\alpha)(\bar{c}_L^\beta \gamma^\mu b_L^\beta)\,, \\
P_3 &= (\bar{s}_L^\alpha \gamma_\mu b_L^\alpha)\textstyle\sum_q (\bar{q}_L^\beta \gamma^\mu q_L^\beta)\,, \\
P_4 &= (\bar{s}_L^\alpha \gamma_\mu b_L^\beta)\textstyle\sum_q (\bar{q}_L^\beta \gamma^\mu q_L^\alpha)\,, \\
P_5 &= (\bar{s}_L^\alpha \gamma_\mu b_L^\alpha)\textstyle\sum_q (\bar{q}_R^\beta \gamma^\mu q_R^\beta)\,, \\
P_6 &= (\bar{s}_L^\alpha \gamma_\mu b_L^\beta)\textstyle\sum_q (\bar{q}_R^\beta \gamma^\mu q_R^\alpha)\,.
\end{aligned}
$$

$b \to s\, l^+ l^-$ transitions:

O_9 & O_{10} + prime operators

O_S & O_P for annihilation processes

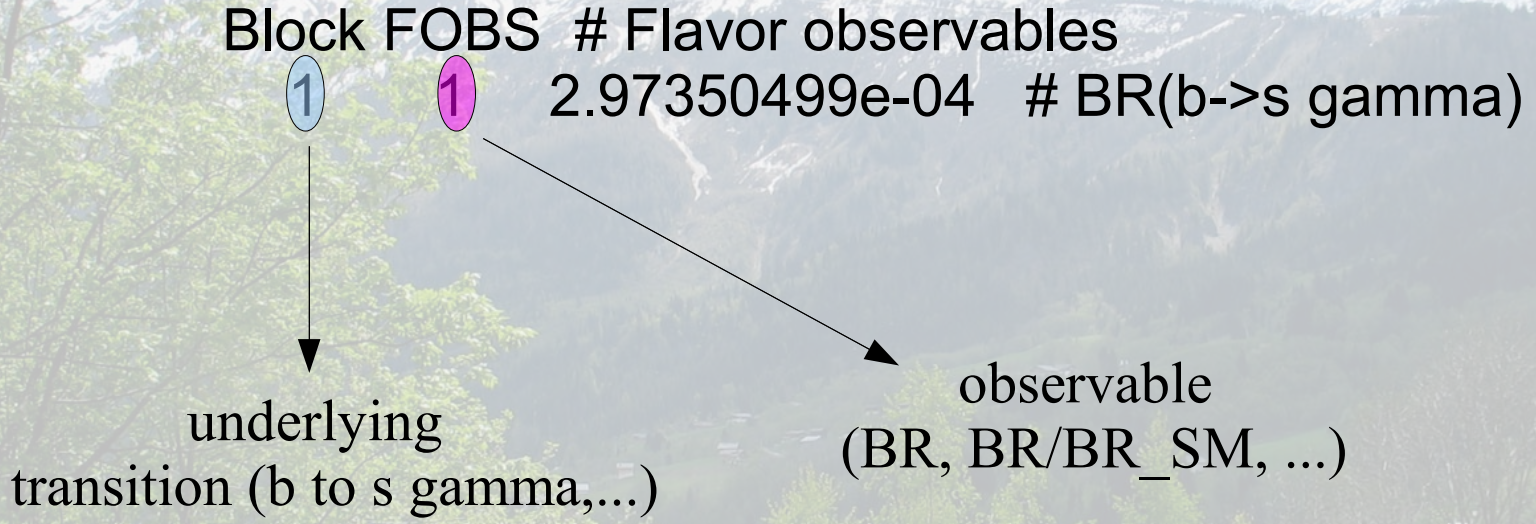
$$O_9 = (\overline{s_L} b_L)(\bar{\gamma}^\mu l l)$$
$$O_{10} = (\overline{s_L} b_L)(\bar{l}\gamma^\mu \gamma_5 l)$$
$$O_S = m_b(\overline{b_R} s_L)(\bar{l} l)$$
$$O_P = m_b(\overline{b_R} s_L)(\bar{l}\gamma_5 l)$$

$b \leftrightarrow s$ oscillations:

Vector, scalar and tensor operators...
+ prime

$$Q^{\mathrm{VLL}} = \left(\overline{b_L}\gamma_\mu s_L\right)\left(\overline{b_L}\gamma^\mu s_L\right)$$
$$Q_1^{\mathrm{LR}} = \left(\overline{b_L}\gamma_\mu s_L\right)\left(\overline{b_R}\gamma_\mu s_R\right)$$
$$Q_2^{\mathrm{LR}} = \left(\overline{b_R} s_L\right)\left(\overline{b_L} s_R\right)$$
$$Q_1^{\mathrm{SLL}} = \left(\overline{b_R} s_L\right)\left(\overline{b_R} s_L\right)$$
$$Q_2^{\mathrm{SLL}} = \left(\overline{b_R}\sigma_{\mu\nu} s_L\right)\left(\overline{b_R}\sigma^{\mu\nu} s_L\right)$$

Flavor observables:



In FeynHiggs:

```
BLOCK PRECOBS
     1    2.36482140E-04   # DeltaRho
     2    8.03907431E+01   # MWMSSM
     3    8.03774213E+01   # MWSM
     4    2.31339440E-01   # SW2effMSSM
     5    2.31413278E-01   # SW2effSM
    11    1.98276773E-09   # gminus2mu
    21    0.00000000E+00   # EDMeTh
    22    0.00000000E+00   # EDMn
    23    0.00000000E+00   # EDMHg
    31    3.44836520E-04   # bsgammaMSSM
    32    3.84208627E-04   # bsgammaSM
```

Do we need to include Block FPRECOBS or do we leave this out?

Example file 2

```
# SuperIso output in Flavor Les Houches Accord format
Block FCINFO  # Program information
     1     SUPERISO         # flavor calculator
     2     2.6              # version number
Block FMODSEL   # Model selection
     1     1   # Extradimension (UED)
Block SMINPUTS  # Standard Model inputs
     1     1.27839951e+02   # alpha_em^(-1)
     2     1.16570000e-05   # G_Fermi
     3     1.17200002e-01   # alpha_s(M_Z)
     4     9.11699982e+01   # m_{Z}(pole)
     5     4.19999981e+00   # m_{b}(m_{b})
     6     1.72399994e+02   # m_{top}(pole)
     7     1.77699995e+00   # m_{tau}(pole)
Block MASS  # Mass spectrum in GeV
#PDG code  mass              particle
     3     1.04000000e-01   # s
     4     1.27000000e+00   # c
    24     8.04229965e+01   # W
Block FMASS  # Hadron mass spectrum in GeV
#PDG code  mass              particle
   211     1.39600000e-01   # pi+
   313     8.91700000e-01   # K*
   321     4.93700000e-01   # K+
   421     1.86484000e+00   # D0
   431     1.96849000e+00   # D_s+
   521     5.27950000e+00   # B+
   531     5.36630000e+00   # B_s
Block FLIFE  # Lifetime in sec
#PDG code  lifetime          particle
   211     2.60330000e-08   # pi+
   321     1.23800000e-08   # K+
   431     5.00000000e-13   # D_s+
   521     1.63800000e-12   # B+
   531     1.42500000e-12   # B_s
Block FCONST  # Decay constant in GeV
#PDG code  decay constant    particle
   431     2.41000000e-01   # D_s+
   521     2.00000000e-01   # B+
   531     2.45000000e-01   # B_s
321211     1.18900000e+00   # f_K/f_pi
```

Block FWCOEF Q= 1.60846e+02
#Effective Wilson coefficients in the standard basis
#order number value
0 2 1.00000000e+00
0 7 -1.82057567e-01
0 8 -1.06651571e-01
1 1 2.33177662e+01
1 4 5.29677461e-01
1 7 1.35373179e-01
1 8 -6.94496405e-01
2 1 3.08498153e+02
2 2 4.91587899e+01
2 3 -7.01872509e+00
2 4 1.25624440e+01
2 5 8.76122785e-01
2 6 1.64273022e+00
2 7 7.05439463e-01
2 8 -4.65529650e+00
Block FWCOEF Q= 2.34384e+00
#Effective Wilson coefficients in the standard basis
#order number value
0 1 -8.47809531e-01
0 2 1.06562816e+00
0 3 -1.34214747e-02
0 4 -1.29110603e-01
0 5 1.36343067e-03
0 6 2.88022278e-03
0 7 -3.73787589e-01
0 8 -1.80398551e-01
1 1 1.52422776e+01
1 2 -2.13433897e+00
1 3 9.52880033e-02
1 4 -4.81776851e-01
1 5 -2.10727176e-02
1 6 -1.22929476e-02
1 7 2.14544819e+00
1 8 -5.16870265e-01
2 7 1.98785400e+01
Block FOBS # Flavor observables
#process observable value
1 1 2.97350499e-04 # BR(b->s gamma)
1 2 8.25882011e-02 # Delta0(B->K* gamma)
2 1 3.46978963e-09 # BR(B_s->mu+ mu-)
3 1 1.09699841e-04 # BR(B_u->tau nu)
3 2 9.96640362e-01 # R(B_u->tau nu)
4 1 6.96556180e-03 # BR(B+->D0 tau nu)
4 2 2.97261612e-01 # BR(B+->D0 tau nu)/BR(B+-> D0 e nu)
5 1 4.81251996e-02 # BR(D_s->tau nu)
6 1 4.96947301e-03 # BR(D_s->mu nu)
7 1 6.45414388e-01 # BR(K->mu nu)/BR(pi->mu nu)
7 2 9.99985822e-01 # R_l23
Block FDOBS # Theoretical error for flavor observables
#process observable error
1 1 2.97350499e-04 # BR(b->s gamma)
Block FOBSSM # SM prediction for flavor observables
#process observable SM value
1 1 2.97350499e-04 # BR(b->s gamma)
Block FPRECOBS # Other observables
1 1.93849647e-10 # a_muon