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Erratum

Mixing-matrix renormalization revisited

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In a recent article [1] we discussed the renormalization of normal coupling matrices. There are two erroneous remarks in [1] that we would like to correct in this note.

In Sect. 4 of [1] we consider the case of a unitary mixing matrix in the context of a model involving two families of N Dirac fermion fields each, with N arbitrary, coupled to a scalar and a massive vector field. If the renormalized mass matrices for fermions M_j, $j = 1, 2$, are chosen in such a way that they are hermitian in each order of perturbation theory, we can write the relation among bare and renormalized mass matrices in the form (see (40) in [1]),

$$\boldsymbol{M}_{j0} = \boldsymbol{U}^{\dagger}_{mjL}(\boldsymbol{M}_j + \overline{\boldsymbol{\delta}}\boldsymbol{M}_j)\boldsymbol{U}_{mjR} \,, \tag{1}$$

with

$$[\boldsymbol{M}_j, \overline{\boldsymbol{\delta}}\boldsymbol{M}_j] = 0 \tag{2}$$

as shown in Appendix A of [1]. This is always the case in OS scheme, in which $\boldsymbol{M}_{1,2}$ are required to be real diagonal at any perturbative order.

It is asserted in [1] that (1) and (2) hold also in MS and related schemes at one loop if the tree-level flavor bases have been chosen so that $\boldsymbol{M}_{1,2}$ are hermitian at tree level. That statement is incorrect. It is not difficult to show that, given the polar decomposition $\boldsymbol{M}_j = \boldsymbol{R}_j\boldsymbol{V}_j$ with $\boldsymbol{R}_j$ hermitian and positive and $\boldsymbol{V}_j$ unitary, the relation (1) holds with $\overline{\boldsymbol{\delta}}\boldsymbol{M}_j = \boldsymbol{\delta R}_j\boldsymbol{V}_j$ where $\boldsymbol{\delta R}_j$ is hermitian and $[\boldsymbol{R}_j, \boldsymbol{\delta R}_j] = 0$, that is,

$$[\boldsymbol{M}_j\boldsymbol{M}_j^{\dagger}, \overline{\boldsymbol{\delta}}\boldsymbol{M}_j\overline{\boldsymbol{\delta}}\boldsymbol{M}_j^{\dagger}] = 0 = [\boldsymbol{M}_j^{\dagger}\boldsymbol{M}_j, \overline{\boldsymbol{\delta}}\boldsymbol{M}_j^{\dagger}\overline{\boldsymbol{\delta}}\boldsymbol{M}_j], \quad j = 1, 2 \,, \tag{3}$$

instead of (2). The substitution of (2) by (3) in the analysis of the model in $\overline{\text{MS}}$ scheme does not affect the other results given in [1] in any way.

Also in Sect. 4 of [1] it is stated that due to gauge invariance only a wave-function renormalization counterterm is needed in the vector field sector of the model. This is true in MS scheme but, of course, other, finite counterterms are needed in OS scheme. The vector boson mass and gauge parameter renormalization, however, are not needed in the analysis presented in that section.

References

1. A. Bouzas, Eur. Phys. J. C **20**, 239–252 (2001)