Erratum: Model for particle masses, flavor mixing, and *CP* violation, based on spontaneously broken discrete chiral symmetry as the origin of families [Phys. Rev. D 59, 015012 (1999)]

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(1) In the denominator in Eq. (47b), $M_F^{2(s)}$ should read $M_F^{2(p)}$. The vacuum saturation approximation formulas of Eqs. (47a) and (48a) correspond to the $N_c \rightarrow \infty$ limit, for which the color factor N (which drops out of the calculation) is 2, not 8/3. Also, some symmetrization factors (amounting to an overall factor of 2) have been omitted in Eqs. (46a)–(50).

(2) The expression for the Cabibbo-Kobayashi-Maskawa (CKM) matrix in Eq. (40c) is incorrect. Corresponding to the diagonalizing transformation of Eq. (40b), the correct expression for the CKM matrix is

$$U_{\mathrm{CKM}} = U_L^u U_L^{d\dagger}, \tag{40c$'$}$$

and defining V_{CKM} now by

$$V_{\mathrm{CKM}} \equiv V_L^u V_L^{d\dagger}, \tag{42a$'$}$$

the first order accurate expression for U_{CKM} becomes

$$U_{\mathrm{CKM}} = \begin{pmatrix} V_{\mathrm{CKM}} & \frac{1}{3} V_L^u \begin{pmatrix} \sigma_{13}^d - \sigma_{13}^u \\ \sigma_{23}^d - \sigma_{23}^u \end{pmatrix} \\ -\frac{1}{3} \begin{pmatrix} \sigma_{13}^d - \sigma_{13}^u \\ \sigma_{23}^d - \sigma_{23}^u \end{pmatrix}^\dagger V_L^{d\dagger} & 1 \end{pmatrix}. \tag{42b$'$}$$

Note that now the off-diagonal matrix elements of U_{CKM} are not proportional to V_{CKM}, but rather involve either V_L^u or V_L^d separately. As a consequence, the spread of s_{13} and s_{23} from their geometric mean is no longer proportional to s_{12}. Instead, writing

$$V_L^u = \begin{pmatrix} c_L^u & -s_L^u \exp(-i\phi_L^u) \\ s_L^u \exp(i\phi_L^u) & c_L^u \end{pmatrix},$$

Eq. (55b) becomes

$$s_{13} = |s_3 - d_3|/3, \quad s_{23} = |s_3 + d_3|/3,$$

$$s_3 \equiv c_L^u(\sigma_{13}^d - \sigma_{13}^u), \quad d_3 \equiv s_L^u \exp(-i\phi_L^u)(\sigma_{23}^d - \sigma_{23}^u), \tag{55b$'$}$$

showing that the spread of s_{13} and s_{23} from their geometric mean is proportional to s_L^u, which is not constrained to be small by the fitting procedure.

(3) The corrections just given to the CKM matrix have a significant impact on the numerical fits of Sec. IX. We find now that the fit incorporating the $K_1 - K_2$ mass difference constraint with low Higgs boson masses is much worse than the fit without this constraint, indicating that satisfying this constraint by fine tuning of the parameters is not natural to the data being fit. Hence some of the Higgs boson masses must be very large; this conclusion can also be reached in a fit-independent manner by including the constraints obtained from experimental limits on the $D_1 - D_2$ mass difference, which together with extended and corrected analytic and numerical results for the Higgs exchange amplitudes will be discussed in detail elsewhere. As a consequence of the change in form of Eq. (55b), in the corrected fit without the $K_1 - K_2$ mass difference constraint, the observed spread of s_{13} and s_{23} from their geometric mean can be fit with small β asymmetry parameters no larger than about 0.05 in magnitude.

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