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Erratum: The muon magnetic moment in the 2HDM: complete two-loop result

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Here we provide corrections to our paper. The corrections are mostly typos in the formulas printed in the paper which do not affect the analytic results implemented in our codes for the numerical analyses. In addition to the typo corrections we improve our approximation formula, eq. (4.4) and the corresponding plots in figures 10 and 11 as explained below. In this context we also mention that the phenomenological discussions of the present paper are updated and superseded by the ones of our successive paper [1].

1. In the Lagrangian eq. (2.14), the abbreviation $y_f^{H^\pm}$ for the Yukawa coupling of the charged Higgs was not defined. Here we provide a slightly rewritten version of the Lagrangian, including all necessary definitions. It assumes CP conservation and all appearing abbreviations to be real and reads

$$\begin{aligned}\mathcal{L}_Y =& \sqrt{2}H^+\left(\bar{u}[V_{\mathrm{CKM}}\, y_d^{H^\pm} P_{\mathrm{R}} + y_u^{H^\pm} V_{\mathrm{CKM}} P_{\mathrm{L}}]d + \bar{\nu} y_l^{H^\pm} P_{\mathrm{R}} l\right)\\ &- \sum_f h\bar{f} y_f^h P_{\mathrm{R}} f - \sum_f H\bar{f} y_f^H P_{\mathrm{R}} f + i\sum_f A\bar{f} y_f^A P_{\mathrm{R}} f + \text{h.c.}\,.\end{aligned}$$

The Yukawa couplings in eq. (2.16) should be replaced by

$$\begin{aligned} Y_f^h &= \sin(\beta-\alpha) + \cos(\beta-\alpha)\zeta_f,\\ Y_f^H &= \cos(\beta-\alpha) - \sin(\beta-\alpha)\zeta_f,\\ Y_{d,l}^{H^\pm} = Y_{d,l}^A &= -\zeta_{d,l}, \quad Y_u^{H^\pm} = Y_u^A = \zeta_u, \end{aligned}$$

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and those in eq. (2.17) should be replaced by

$$Y_f^h = 1+\eta\zeta_f, \quad Y_f^H = -\zeta_f+\eta, \quad Y_f^{H^\pm} = Y_f^A = -\Theta_f^A\zeta_f,$$
$$\Theta_{d,l}^A = 1, \qquad \Theta_u^A = -1, \qquad \Theta_{u,d,l}^H = 1,$$

which includes $Y_f^{H^\pm}$.

2. In eq. (3.26) v is missing in the triple Higgs coupling constant. The correct formula is

$$g_{H,H^\pm,H^\mp} \propto \left\{ \left(t_\beta - \frac{1}{t_\beta}\right)\frac{v}{2}\left(\Lambda_5 - 2\frac{M_H^2}{v^2}\right) + \eta\, v\left(\Lambda_5 - \frac{M_H^2}{v^2} - 2\frac{M_{H^\pm}^2}{v^2}\right)\right\}.$$

3. Page 19, line 2: $M_l = \{(m_e,0),(m_\mu,0),(m_\tau,0)\}$.
4. There was an unnecessary, extra $\Phi(x_d^{1/2}, x_u^{1/2}, 1)$ in the second line of eq. (3.36), and its corrected version reads

$$\begin{aligned}\mathcal{F}_d^{H^\pm}(M_d) = &-(x_u - x_d) + \left[\frac{\bar{c}}{y} - c\left(\frac{x_u - x_d}{y}\right)\right]\Phi(x_d^{1/2}, x_u^{1/2}, 1)\\ &+ c\left[\mathrm{Li}_2\left(1 - \frac{x_d}{x_u}\right) - \frac{1}{2}\ln(x_u)\ln\left(\frac{x_d}{x_u}\right)\right]\\ &+ (s + x_d)\ln(x_d) + (s - x_u)\ln(x_u).\end{aligned}$$

5. A factor of $-\frac{1}{2}$ was missing in eq. (A.11), and the correct expression is

$$\begin{aligned}\mathcal{T}_7(u,\omega) = &-\frac{f_5}{2}(2(u+\omega) - (u-\omega)^2 - 1)\ln\left(\frac{\mathcal{S}_1(u,\omega)}{2\sqrt{u\omega}}\right)\\ &\times\left(u + \omega - 1 - \frac{4u\omega}{\mathcal{S}_1(u,\omega)}\right).\end{aligned}$$

6. In the numerical evaluation of our results we have used one-loop corrected relationships between the electroweak parameters: s_W, c_W, M_W, M_Z, v. In this way, the numerical evaluation of a_μ contains certain terms which are formally of 3-loop order but which do not correspond to a full 3-loop calculation. In the following we provide results based on an evaluation which uses tree-level relationships between these electroweak parameters and which thereby corresponds to a pure 2-loop calculation in the on-shell renormalization scheme.

   According to the original numerical implementation, there was a slight increase with t_β visible in the original figure 10a, and figures 10d and 11 for $t_\beta = 100$ were affected by the incomplete 3-loop effects mentioned above. Actually, the linear large-t_β-enhancement vanishes in the new, strict 2-loop evaluation. This can be understood with the help of eq. (4.4). This equation can now be analytically evaluated by using the tree-level relationships for the electroweak parameters in eqs. (2.13) and (A.32). In this case, the term proportional to $M_H^2\zeta_l t_\beta$ on the far right-hand side of eq. (4.4) analytically vanishes. In the approximation of large t_β, the far right-hand side of eq. (4.4) contains only terms which decrease or approach a constant for large t_β.

JHEP10(2021)242

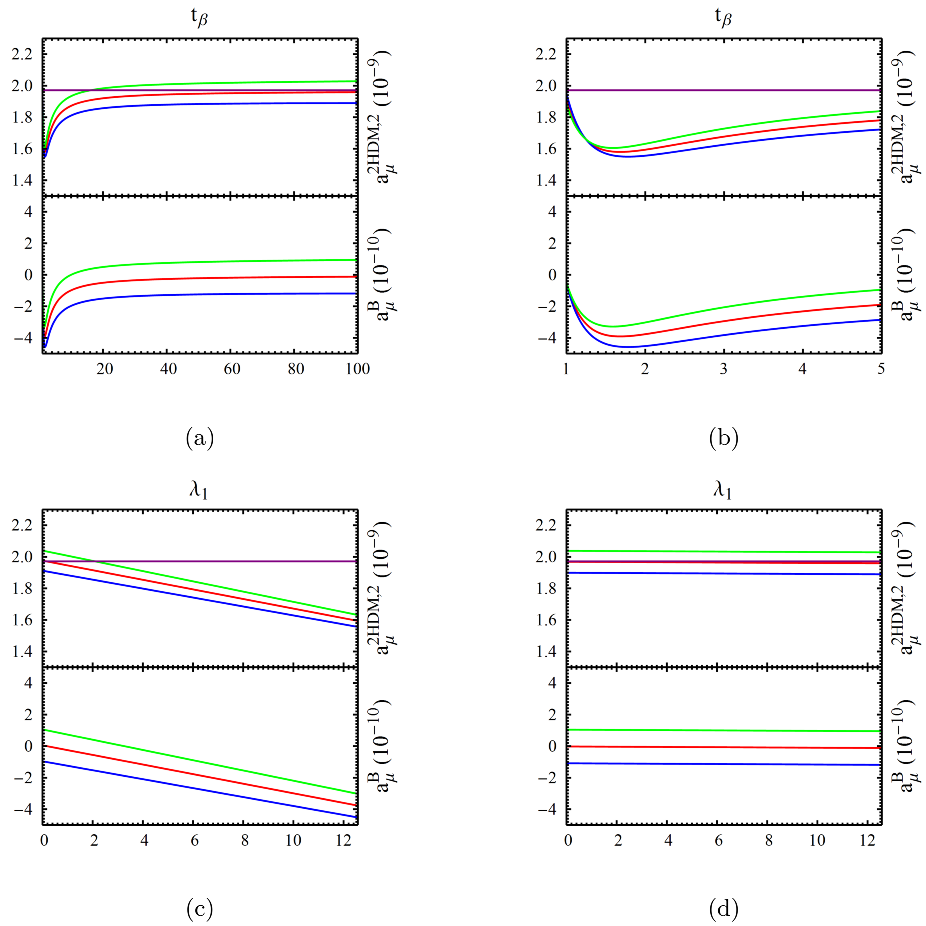
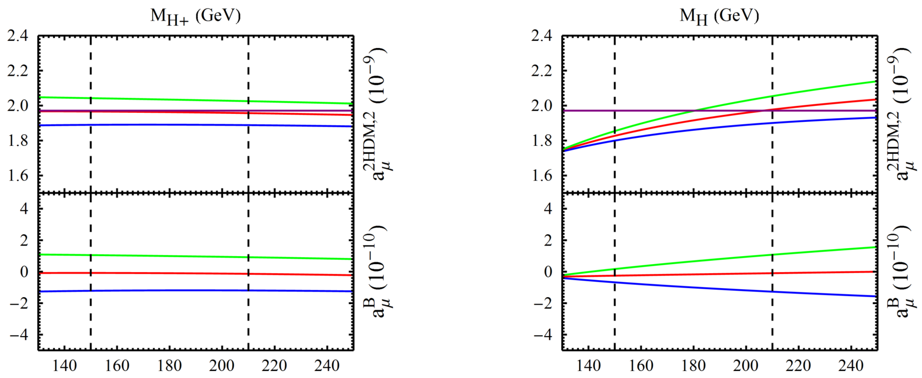


Figure 1. Revised version of figure 10. Plots showing the behavior of $a_\mu^{2\mathrm{HDM},2}$, and a_μ^{B}. Each red/blue/green line is for $\eta = 0/0.1/{-0.1}$. t_β varies for (a) and (b), and λ_1 for (c) and (d). We consider the representative mass parameter point in eq. (4.3). $\lambda_1 = 4\pi$ for (a) and (b). We employ $t_\beta = 2$ and $t_\beta = 100$ for (c) and (d) respectively.

Here we provide revised versions of the plots in figures 10 and 11 with the modified numerical evaluation using tree-level relations between electroweak parameters: see figures 1 and 2. Here the linear increase in t_β is absent and the numerical results in the large t_β regime are slightly changed. Again, we refer to ref. [1] for a more detailed phenomenological evaluation which also takes into account a variety of experimental constraints on the input parameters ζ_l, t_β, and η.

JHEP10(2021)242



(a) (b)

Figure 2. Revised version of figure 11. Plots showing the behavior of $a_\mu^{\mathrm{2HDM,2}}$, and a_μ^{B}. Each red/blue/green line is for $\eta = 0/0.1/{-0.1}$. $M_{H^\pm}$ and M_H vary in (a) and (b) respectively. We set $\lambda_1 = 4\pi$, and $t_\beta = 100$. The inside regions between the dashed lines are allowed by constraints. The purple line is a reference value as explained in the text.

Acknowledgments

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References

[1] A. Cherchiglia, D. Stöckinger and H. Stöckinger-Kim, *Muon $g-2$ in the 2HDM: maximum results and detailed phenomenology*, *Phys. Rev. D* **98** (2018) 035001 [arXiv:1711.11567] [INSPIRE].

JHEP10(2021)242