Addendum to "Two Higgs doublet model predictions for $\bar{B}\to X_s\gamma$ in NLO QCD"

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We update our previous work [Phys. Rev. D **58**, 074004 (1998)], by taking into account the recently calculated electromagnetic corrections. We present a new exclusion contour plot $(\tan(\beta),m_H)$, where these corrections are included. [S0556-2821(99)01505-2]

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Recently, several papers appeared that include different classes of electroweak corrections [2–4] to the process $\mathrm{BR}(\bar{B}\to X_s\gamma)$. In Ref. [4], corrections to the Wilson coefficients at the matching scale due to the top quark and the neutral Higgs boson were calculated and found to be negligible. The analysis [2] concluded that the most appropriate value of $\alpha_{\rm em}^{-1}$ to be used for this problem is the fine structure constant $\alpha^{-1}=137.036$ instead of the value $\alpha_{\rm em}^{-1}=130.3\pm 2.3$ previously used. In Ref. [3], the leading logarithmic QED corrections of the form $\alpha\log(\mu_W/\mu_b)[\alpha_s\log(\mu_W/\mu_b)]^n$ (with resummation in n) were given.

We update our results of Ref. [1] for the branching ratio $\mathrm{BR}(\bar{B}\to X_s\gamma)$ in the standard model (SM) and for the exclusion contour plot $(\tan\beta,m_H)$ in a 2 Higgs doublet model (2HDM) of type II, by changing the value of $\alpha_{\rm em}$ and by including the class of QED corrections presented in Ref. [3]. They can be used to improve $\mathrm{BR}(\bar{B}\to X_s\gamma)$ in any extension of the SM which does not increase the set of effective operators relevant for the problem.

In the SM, we obtain

$$\mathrm{BR}(\bar{B}\to X_s\gamma)=[3.32\pm^{0.00}_{0.11}(\mu_{\rm b})\pm^{0.00}_{0.08}(\mu_{\rm W})\pm^{0.26}_{0.25}(\mathrm{param})]\times 10^{-4}. \tag{1}$$

The bulk of the change with respect to the value presented in Ref. [1] is due to the different value of $\alpha_{\rm em}^{-1}$ used. In a 2HDM of type II, the new exclusion plot in $(\tan\beta,m_H)$, obtained for different possible experimental upper bounds for $\mathrm{BR}(\bar{B}\to X_s\gamma)$, is shown in Fig. 1. Each curve is obtained minimizing $\mathrm{BR}(\bar{B}\to X_s\gamma)/\mathrm{BR}(b\to c l\nu_l)|_{\rm theor}$ by varying the input parameters within their range of errors and the two scales μ_b and μ_W as described in Ref. [1], for each value of $\mathrm{BR}(\bar{B}\to X_s\gamma)|_{\rm exp}$ considered.

As already mentioned in Ref. [1], one should bear in mind that the error in Eq. (1) as well as that considered to obtain the exclusion curves in Fig. 1 does not include all possible uncertainties in the theoretical estimate of $\mathrm{BR}(\bar{B}\to X_s\gamma)$. A different way of handling the semileptonic width $\Gamma_{\rm SL}$, for example, retaining only the first term in the α_s expansion of $1/\Gamma_{\rm SL}$ lowers the central value of $\mathrm{BR}(\bar{B}\to X_s\gamma)$ from 3.32×10^{-4} to 3.22×10^{-4} in the standard model. Similarly, the different treatment of $1/\Gamma_{\rm SL}$ leads to shifts of the exclusion curves in Fig. 1 by tens of GeV for $\mathrm{BR}(\bar{B}\to X_s\gamma)\sim 4\times 10^{-4}$ or more for smaller values of $\mathrm{BR}(\bar{B}\to X_s\gamma)$. A similar effect has to be expected for additional electroweak corrections not included here, which presumably will not exceed the 2% level [2,4].

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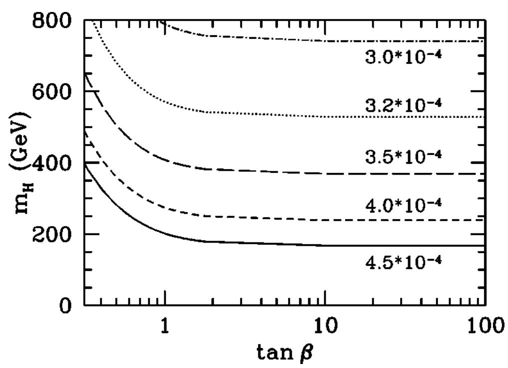

FIG. 1. Contour plot in $(\tan\beta,m_H)$ obtained by using the NLO expression for the branching ratio $\mathrm{BR}(\bar{B}\to X_s\gamma)$ and possible experimental upper bounds. The allowed region is above the corresponding curves.

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