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Nonfactorizable charm loop in rare $B_s \to \gamma\, l^+ l^-$ decay

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We present the first theoretical calculation of nonfactorizable charm-quark loop contributions to the $B_s \to \gamma\, l^+ l^-$ amplitude. This contribution involves the B-meson three-particle Bethe-Salpeter amplitude, $\langle 0|\bar{s}(y)G_{\mu\nu}(x)b(0)|\bar{B}_s(p)\rangle$, for which we take into account constraints from analyticity and continuity. We calculate the relevant form factors, $H^{\rm NF}_{A,V}(k'^2, k^2)$, and provide convenient parametrizations of our results, applicable in the region below hadron resonances, $k'^2 < M^2_{J/\psi}$ and $k^2 < M^2_\phi$. We report that factorizable and nonfactorizable charm contributions to the $B_s \to \gamma\, l^+ l^-$ amplitude have opposite signs. To compare the charm and the top contributions, the nonfactorizable charming loop contribution is expressed as a non-universal (i.e., dependent on the reaction) q^2-dependent correction $\Delta^{\rm NF}C_7(q^2)$ to the Wilson coefficient C_7. For the $B_s \to \gamma\, l^+ l^-$ amplitude the correction is found to be positive, $\Delta^{\rm NF}C_7(q^2)/C_7 > 0$. Our numerical results for the form factors $H_i^{\rm NF}(k'^2, k^2)$ depend sizeably on the precise value of the parameter λ_{B_s}, and for a fixed value of λ_{B_s}, $H_i^{\rm NF}(k'^2, k^2)$ may be calculated with about 10% accuracy.

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