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$\bar{B}^0_{s,d} \to J/\psi\mu^+\mu^-$ Decays in QCD Factorization

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Motivated by the first LHCb searches for the rare $\bar{B}^0_{s,d} \to J/\psi\mu^+\mu^-$ decays, we perform a detailed study of these processes within the QCD factorization formalism. Since the transverse size of the J/ψ meson is small in the heavy quark mass limit, this formalism is generally expected to hold for these decays. We include both the leading- and the next-to-leading-order QCD corrections to the hard-scattering kernels, which are convoluted with the light-cone distribution amplitudes (LCDAs) of the initial- and final-state hadrons. It is numerically found that, depending on the model parameters for the leading-twist B-meson LCDA, the maximum branching ratios of $\bar{B}^0_s \to J/\psi\mu^+\mu^-$ and $\bar{B}^0_d \to J/\psi\mu^+\mu^-$, integrated over the dimuon invariant mass squared q^2 from $1\,\mathrm{GeV}^2$ to $(m_{B_{s,d}} - m_{J/\psi})^2$, can reach, respectively, up to 2.21×10^{-9} and 7.69×10^{-11} at the leading order in α_s. After incorporating the non-factorizable one-loop vertex corrections, these branching ratios are further reduced by about one order of magnitude, with $\mathcal{B}(\bar{B}^0_s \to J/\psi\mu^+\mu^-)|_{q^2 \geq 1\,\mathrm{GeV}^2} = 2.88 \times 10^{-10}$ and $\mathcal{B}(\bar{B}^0_d \to J/\psi\mu^+\mu^-)|_{q^2 \geq 1\,\mathrm{GeV}^2} = 1.07 \times 10^{-11}$. In addition, we have presented the dimuon invariant mass distributions of the individual and total helicity amplitudes squared, as well as the differential and integrated longitudinal polarization fractions of the J/ψ meson, which could be probed by the future LHCb and Belle II experiments with more accumulated data.

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