

Deciphering the long-distance penguin contribution to $B \rightarrow \gamma\gamma$ decays

Wednesday, August 10, 2022 10:05 AM (15 minutes)

We compute for the first time the long-distance penguin contribution to the double radiative B -meson decays due to the purely hadronic operators acting with the electromagnetic current in the background soft-gluon field

from first field-theoretical principles by introducing a novel subleading B -meson distribution amplitude.

The numerically dominant penguin amplitude arises from the soft-gluon radiation off the light up-quark loop rather than the counterpart charm-loop effect on account of the peculiar analytical behaviour of the short-distance hard-collinear function. Importantly the long-distance up-quark penguin contribution brings about the substantial cancellation of the known factorizable power correction possessing the same multiplication CKM parameters, thus enabling $B_{d,s} \rightarrow \gamma\gamma$ to become new benchmark probes of physics beyond the Standard Model.

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Session Classification: Parallel Session III (2): Hadron and Flavor Physics

Track Classification: 强子物理与味物理