Contribution ID: **229** Type: **Parallel Talk**

Finite-volume collinear divergences in radiative corrections to meson leptonic decays

Friday, 4 August 2023 09:40 (20 minutes)

In the context of radiative corrections to pseudoscalar meson leptonic decay, it is well-known that the $\mathcal{O}(\alpha_{\rm em})$ corrections to the decay amplitude logarithmically diverges when the lepton mass goes to zero, a behavior known as collinear divergences. Since leptons are not massless, this is not per se a divergence of the process, but it greatly enhances the value of the amplitude in cases where the lepton in the final state is hyper-relativistic. This occurs for example in the decay of D^+ and D_s^+ into a muon and a neutrino, relevant for CKM matrix elements determination. In an infinite volume, collinear divergences are known to be logarithmic and independent of the direction of the lepton momentum. In this talk, we demonstrate that in a finite volume, these divergences have a very complex angular dependence, likely of number theoretical nature. Although it is challenging to understand this structure analytically, we present properties obtained through numerical experiments. Finally, we conclude on the implication for lattice calculations, and possible strategies for mitigating this class of volume effects.

Topical area

Quark and Lepton Flavor Physics

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Session Classification: Quark and Lepton Flavor Physics