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$K_L \to \mu^+\mu^-$ from lattice QCD

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We discuss the applicability of lattice QCD to the long-distance (LD) two-photon contribution to the decay of a long-lived neutral kaon into a charged-muon pair (KL2mu). In the absence of QED, the flavor-changing neutral-current KL2mu process requires exchanging at least two W-bosons or a W- and a Z-boson, the short-distance (SD) contribution. Such a process is suppressed by two factors of the Fermi constant G_F and the appearance of loop diagrams makes it sensitive to physics at higher energy scales. Despite its rareness, the experimental KL2mu decay rate is known to 1.6 percent, which makes it an appealing precision probe of the Standard Model. With QED, the two-photon exchange contribution to KL2mu enters at O($G_F\alpha^2_{QED}$). This LD two-photon contribution is of the same order as the SD contribution predicted by electroweak perturbation theory. We demonstrate that it is possible to make a first-principles calculation of the full complex LD two-photon decay amplitude using lattice QCD; in particular, the dispersive part of the amplitude, which is inaccessible from phenomenology, can be obtained. Preliminary numerical results of the quark-connected contribution will be presented.

Topical area

Quark and Lepton Flavor Physics

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