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Estimating finite volume effects in QCD+QED simulations by using relativistic EFTs

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Lattice QCD simulations have entered the precision era. Thanks to the combined efforts of several lattice collaborations, the masses, leptonic and semileptonic decay rates of light pseudoscalar mesons are presently known, in QCD, with sub-percent relative errors. At this level of precision strong isospin breaking and QED radiative corrections cannot be neglected and have to be taken into account with the required non-perturbative accuracy. This can in principle be done by performing lattice simulations of QCD+QED. The inclusion of the electromagnetic interactions in finite volume lattice simulations, however, poses both theoretical and numerical problems. A particularly important issue are the finite volume effects. In the case of the masses of stable hadrons these are power-law suppressed in QCD+QED while they vanish exponentially fast in QCD. The issue becomes much more delicate in the case of decay rates where one has to cope with the well known problem of the infrared divergences, i.e. with diverging finite volume effects, that might appear at intermediate stages of the calculations. In this lecture I will discuss how finite volume effects in QCD+QED can be understood and estimated by using relativistic effective field theories techniques. I will discuss in particular the cases of the finite volume effects on the masses of stable hadrons and of the infrared divergences appearing in the leptonic decay rates of pseudoscalar mesons.

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