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Introduction to QCD+QED in finite volume

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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.

In particular, as a consequence of Gauss law, electrically-charged states are absent in a finite volume with periodic boundary conditions. While this statement is fairly trivial al the classical level, I will discuss in some detail what it means at the quantum-mechanical level. We will see how C-parity boundary conditions can be used to circumvent this problem in a fully consistent way (and in fact it is the only way if one insists on gauge and translational invariance). A possible lattice discretization of QCD+QED will also be discussed.

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