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Photon Propagator in Confinement and Deconfinement Phases of Lattice QED

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Quantum electrodynamics (QED) is the gauge field theory that describes the interactions between photons and charged particles, characterized by gauge invariance under the group U (1) [1]. Understanding how QED works is essential to describe one of the fundamental forces of the universe, eletromagnetism,this can be investigated from various perspectives, including experimental, perturbative [2], and lattice approaches [3]. In this study, we adopt the lattice formulation to simulate and analyze QED, employing Monte Carlo techniques.

The photon propagator, a key object in QED, provides the probability amplitude for a photon to travel from one point in spacetime to another. It also describes how photons transmit their effects through spacetime. Understanding the behavior of the photon propagator is crucial for exploring QED phenomena.

In lattice QED, a unique phenomenon emerges that is not observed in nature: a confinement phase. This divides the lattice QED into two distinct regions—the confinement and deconfinement phases [4]. This phase structure can be attributed to lattice properties and understanding how this phase structure arises and how to deal with it is essencial to improve our data and extract physical meaning.

In this study, we compute the photon propagator in both phases on a lattice of size 204. We utilize the Los Alamos algorithm for gauge fixing and the Heat Bath Monte Carlo algorithm for thermalization and configuration generation.

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