Contribution ID: **200** Type: **Oral Presentation**

Strategies for the Determination of the Running Coupling of $(2+1)$-dimensional QED with Quantum Computing (I): Motivations and Theoretical Foundations

In our work we study lattice QED in 2+1 dimensions,
which serves as a toy model for 3+1-dimensional QCD due to similarities in the behaviour of running coupling.
Moreover, the theory exhibits a rich and interesting phenomenology in itself and can be extended by including a topological term, non-zero matter density and time evolution.
Our main goal is to match physical quantities, such as mass gap and static force, between results obtained via quantum computing and Monte Carlo (MC) methods.
As a first step, we describe the QED system on the lattice: we consider Kogut-Susskind fermions with periodic boundary conditions. A discretization and truncation of the gauge group $U(1)$ is then introduced,
discussing possible encoding in the quantum circuit paradigm. In the analysis, we consider exact diagonalization results for both the electric and magnetic basis,
commenting on the convergence properties in terms of the coupling and truncation level. We then present two ideas to compute the running coupling. The first proposal is to use a step scaling approach, based on measurements of the static potential, and a match with MC for physical units in the intermediate to large coupling regime. From those results it is possible to compute the renormalized coupling and the Λ parameter along with perturbation theory calculations. The second proposal is a boosted coupling approach, i.e. redefine the perturbative expansion of the coupling constant by including the expectation value of the plaquette operator.
In addition, we describe the scale setting by determining the renormalization scale in physical units for which the lattice spacing needs to be calculated.

Primary authors: CRIPPA, Arianna; CLEMENTE, Giuseppe (DESY - Zeuthen); JANSEN, Karl (DESY)

Presenter: CLEMENTE, Giuseppe (DESY - Zeuthen)

Session Classification: Algorithms

Track Classification: Algorithms (including Machine Learning, Quantum Computing, Tensor Networks)