Contribution ID: **153** Type: **Parallel Talk**

Infrared Phases of 2d QCD from Qubit Regularization

Monday, 31 July 2023 16:20 (20 minutes)

Qubit regularization provides a framework for studying gauge theories through finite-dimensional local Hilbert spaces, presenting opportunities for digital quantum simulations. In this talk, we investigate the IR phases of 2d QCD with the $\mathrm{SU}(N)$ gauge group via qubit regularization. In the continuum, a 2d $\mathrm{SU}(N)$ gauge theory coupled to a single flavor of fundamental massless Dirac fermions can be bosonized into an $\mathrm{SO}(2N)_1/\mathrm{SU}(N)_1$ Wess-Zumino-Witten (WZW) model or a compact boson. On the lattice, utilizing a strong-coupling expansion of the qubit-regularized Kogut-Susskind Hamiltonian with the assistance of a generalized Hubbard coupling, we demonstrate that the continuum physics can be reproduced by an XXZ spin chain, together with a gapped phase. We also show the existence of a confinement/deconfinement (screening) transition. These arguments are verified numerically in the $\mathrm{SU}(2)$ case using the tensor network approach. Our numerical results reveal that the lattice model has a central charge of 1, and its spectrum can be understood as the $\mathrm{SU}(2)_1$ WZW model perturbed by a tiny marginally irrelevant operator, which can be tuned away by the Hubbard coupling. The confinement/deconfinement transition is also verified numerically by measuring the string tensions.

Topical area

Theoretical Developments

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Session Classification: Theoretical Developments