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Grassmann tensor-network method for strong-coupling QCD

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We present a tensor-network method for strong-coupling QCD with staggered quarks at nonzero chemical potential. After integrating out the gauge fields at infinite coupling, the partition function can be written as a full contraction of a tensor network consisting of coupled local numeric and Grassmann tensors. To evaluate the partition function and to compute observables, we develop a Grassmann higher-order tensor renormalization group method, specifically tailored for this model. We apply the method to the two-dimensional case and validate it by comparing results for the partition function, the chiral condensate and the baryon density with exact analytical expressions on small lattices up to volumes of 4×4. For larger two-dimensional volumes, we present first tensor results for the chiral condensate as a function of the mass and volume, and observe that the chiral symmetry is not broken dynamically in two dimensions. We also present tensor results for the number density as a function of the chemical potential, which hint at a first-order phase transition.

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