1. Real-time scattering in Ising field theory using matrix product states
   with A. Milsted, D. Neuenfeld, J. Preskill, and P. Vieira
   Phys. Rev. Res. 7 (2025) 2, 023266

   The study of inelastic and elastic scattering processes at high and moderate energies is a hard problem for interacting field theories. A long-term goal of the lattice community is to be able to perform real-time scattering processes in QCD. We performed the largest matrix product state (MPS) tensor network computation consisting of up to 2000 qubits of an interacting field theory with energy up to $8m$ where m is the lightest particle in the theory and probed the analytical structure of the S-matrix including resonances in the Ising field theory.

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2. Quantum computation of $SU(2)$ lattice gauge theory with continuous variables (CV)
   with V. Ale, N. Bauer, F. Ringer, and G. Siopsis
   JHEP 06 (2025) 084

   This work carried out the first study of any non-Abelian gauge theory ($SU(2)$ lattice gauge theory) using continuous variables (i.e., harmonic oscillators/qumodes) and Kogut-Susskind Hamiltonian in maximal tree gauge, a special gauge first proposed by Creutz in 1977. After gauge fixing, we found that the resources to simulate real-time dynamics of this theory scales polynomially with the number of qumodes and CV gates, a necessary condition for obtaining advantage of quantum computation methods over classical methods.

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3. Sachdev-Ye-Kitaev model on a noisy quantum computer
   with M. Asaduzzaman, and B. Sambasivam
   Phys. Rev. D 109, 105002 (2024)

   We explored the simplest holographic model, known as the SYK model on IBM's 127-qubit processors for small number of fermions. We optimized the two-qubit gate costs of quantum simulation using Trotter method and achieved good improvement over the existing results in the literature. We then computed return probability and out-of-time-order (OTOC) correlators used to characterize quantum chaos on the hardware making use of combination of error mitigation methods obtained agreement with exact results for circuit depth of more than 300 two-qubit gates.

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4. Continuous-variable quantum computation of the $O(3)$ model in dimensions
   with F. Ringer, G. Siopsis, and S. Thompson
   Phys. Rev. A 109, 052412 (2024)

   This work carried out the first study of any continuous spin model (the well-known sigma model, that shares several interesting properties with QCD such as asymptotic freedom and dynamical mass generation via dimensional transmutation) in 1+1-dimensions within the framework of continuous-variable quantum computing rather than the more popular approach using discrete variables (qubits).

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5. $SU(2)$ principal chiral model with tensor renormalization group on a cubic lattice
   with S. Akiyama, and J.Unmuth-Yockey
   Phys. Rev. D 110, 034519 (2024)

This work carried out the first systematic study of a famous toy model - $SU(2)$ principal chiral model in three Euclidean dimensions and obtained the critical temperature and correct RG scaling behavior corresponding to the continuous phase transition. This toy model will eventually pave way for studies of QCD-like theories at finite chemical potential using tensor renormalization group (TRG) methods.

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6. Non-perturbative phase structure of the bosonic BMN matrix model
   with N. S. Dhindsa, A. Joseph, A. Samlodia, and D. Schaich
   JHEP 05 (2022) 169 We studied the phase diagram of an important holographic matrix model known as the 'BMN matrix model' focusing on the bosonic sector of the theory by performing numerical computations at large N.

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7. Tensor renormalization group study of the three-dimensional O(2) model
   with J. Bloch, R. Lohmayer, and M. Meister
   Phys. Rev. D 104, 094517 (2021)

   This work carried out the first study of a continuous spin model in three Euclidean dimensions at finite chemical potential using tensor RG methods. Due to the sign problem, this lies beyond the capability of standard Monte Carlo methods.

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8. Three-dimensional super-Yang–Mills theory on the lattice and dual black branes
   with S. Catterall, J. Giedt, D. Schaich, and T. Wiseman
   Phys. Rev. D 102, 106009 (2020)

   This work extends our earlier work on holographic checks to three-dimensional supersymmetric gauge theories at large N.

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9. Tensor renormalization group study of the non-Abelian Higgs model in two dimensions
   with A. Bazavov, S. Catterall, and J.Unmuth-Yockey
   Phys. Rev. D 99, 114507 (2019)

   In the past five decades, continuum gauge theories have been widely explored using lattice Monte Carlo methods. However, there are cases where these methods fail. In the early 2000s, tensor networks were introduced as an alternative. In this paper, we explored a real-space coarse-graining tensor algorithm to study SU(2) non-Abelian gauge theory and showed that it is able to match the results of Monte Carlo methods. Following this work, several groups have extended our efforts to $SU(3)$ and more complicated models using real-space tensor methods.

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10. Testing holography using lattice super-Yang-Mills theory on a 2-torus
    with S. Catterall, D. Schaich, and T. Wiseman
    Phys. Rev. D 97, 086020 (2018)

    The holographic conjecture relates supersymmetric gauge theories in certain limits to theories of quantum gravity. However, there is no proof of this conjecture beyond some special cases. In this paper, we performed a lattice study of strongly coupled gauge theory in an appropriate limit to compute observables in classical supergravity. This paper provided a non-trivial first principles test of gauge/gravity duality (holography) at finite temperatures. Since this paper, we have extended this work to one higher dimension and found that lattice results qualitatively agree with black hole computations.