U.S. ARMY RDECOM

Investigation of entanglement dynamics

ARL open campus

S&T Campaign: Computational Sciences
Advanced *Computing Architectures*

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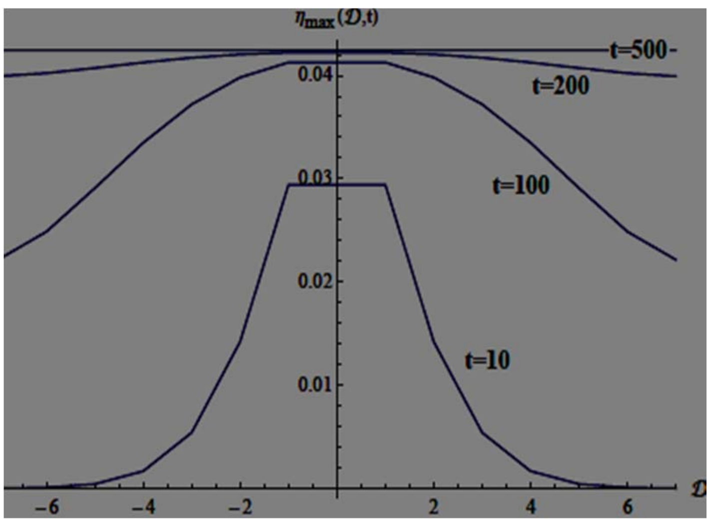
Research Objective

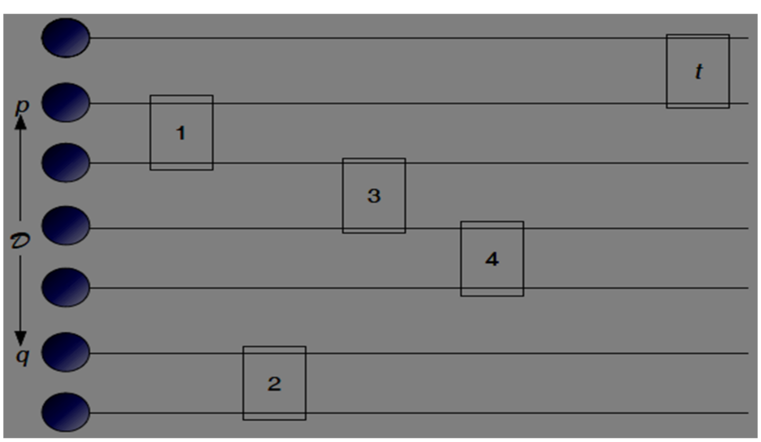
- Understanding propagation of Quantum Correlations in Local Random Quantum Circuits (LRQC)
- Leverages piecewise quantum phenomena under stochastic classical control for Quantum Information Processing.

Challenges

- Mathematical modeling for arbitrary models of LRQC
- Estimating combinatorial sums over paths in non-uniform graphs.



Propagation of correlations in LRQCs with time



Local Random Quantum Circuit

ARL Facilities and Capabilities Available to Support Collaborative Research

- Theory team with Quantum Information and Control expertise.
- Clusters and research supercomputers.
- Preprint available: http://arxiv.org/abs/1506.03323
- Main Results
  - For t=O(L) correlations spread within a strictly linear light cone and grow atmost diffusively within the cone.
  - For t=O(L^2) correlations spread throughout the system and approach the asymptotic maximum.

$$\sqrt{\overline{\|[\hat{O}_p,\hat{O}_q]\|_2^2}^{C^t}} \leq_{t\to\infty} \frac{1}{d}\sqrt{2\left(1-\frac{dx^2+dy^2-x^2y^2}{d^2}\right)}\|\hat{O}_p\|_2\|\hat{O}_q\|_2 \quad \forall\{p,q\}\in V$$

Complementary Expertise/ Facilities/ Capabilities Sought in Collaboration

- Establish connections to Classical and Quantum Random Walks and algorithms based on those.
- Frame Error models in the gate model of Quantum computation as Random Quantum Circuits.
- Experiments using any physical realization of lattice spin systems.

- References and related work

- Quantum Entanglement in Random Physical States, PRL 109, 040502, 2012 - A. Hamma, S. Santra, P. Zanardi.
- Local Random Quantum Circuits are approximate polynomial designs, 1208.0692 – F. Brandao, A. Harrow, M. Horodecki.

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