

[Invited Talk] Spatio-temporal tensor networks describing volume law states and their efficient contraction

Friday 10 October 2025 09:00 (35 minutes)

I will review how spatio-temporal tensor networks naturally arise in the computation of expectation values following quantum quenches [1], and how they encode the dynamical properties of many-body quantum systems. Particular emphasis will be given to the concept of generalized temporal entanglement [2], a quantity that captures the entanglement structure across time, provides insight into the complexity of contracting such networks and can be measured experimentally [3].

This motivates the use of generalized temporal entanglement as a diagnostic tool for understanding the computational cost of simulating out-of-equilibrium quantum dynamics. I will present analytical results for its scaling in critical Hamiltonians [4], highlighting a universal structure that allows us to identify and characterize emergent dynamical critical points [5].

Finally, I will introduce a new tensor network algorithm that exploits these insights to efficiently predict the evolution of local observables using only polynomial resources [5].

[1] Spatio-temporal tensor-network approaches to out-of-equilibrium dynamics bridging open and closed systems

S Cerezo-Roquebrún, A Bou-Comas, JT Schneider, E López, Luca Tagliacozzo, Stefano Carignano, *Frontiers in Quantum Science and Technology* 4, 1568471.

[2] Temporal entropy and the complexity of computing the expectation value of local operators after a quench
S Carignano, CR Marimón, L Tagliacozzo

Physical Review Research 6 (3), 033021.

[3] Measuring temporal entanglement in experiments as a hallmark for integrability

A Bou-Comas, CR Marimón, JT Schneider, S Carignano, L Tagliacozzo

arXiv preprint arXiv:2409.05517.

[4] Loschmidt echo, emerging dual unitarity and scaling of generalized temporal entropies after quenches to the critical point

S Carignano, L Tagliacozzo

arXiv preprint arXiv:2405.14706

[5] Overcoming the entanglement barrier with sampled tensor networks

S Carignano, G Lami, J De Nardis, L Tagliacozzo

arXiv preprint arXiv:2505.09714

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