Sequential generation of tensor network states

Z.Y. Wei[*1,2], **D. Malz**[1,2], **A.G.Tudela**[3], **J.I.Cirac**[1,2]

1. Max-Planck-Institut für Quantenoptik, Hans-Kopfermann-Straße 1, D-85748 Garching, Germany

2. Munich Center for Quantum Science and Technology (MCQST), Schellingstr. 4, D-80799 München

3. Instituto de Física Fundamental IFF-CSIC, Calle Serrano 113b, Madrid 28006, Spain

The sequential generation of tensor network states provides a way to deterministically prepare entangled states on both matter-based and photon-based quantum devices. In this talk, first, we discuss two implementations to sequentially generate photonic matrix product states (MPS), one based on a Rydberg atomic array [1], and another based on a microwave cavity dispersively coupled to a transmon [2]. We show both implementations can generate a large number of entangled photons. Then, we introduce plaquette projected entangled-pair states (p-PEPS) [3], a class of states in a lattice that can be generated by applying sequential unitaries acting on plaquettes of overlapping regions. They satisfy area-law entanglement, possess long-range correlations, and naturally generalize other relevant classes of tensor network states. We identify a subclass that can be more efficiently prepared in a radial fashion and that contains the family of isometric tensor network states. We also show how such subclass can be efficiently prepared using an array of photon sources, and devise a physical realization by extending the above cavity-transmon setup [2].

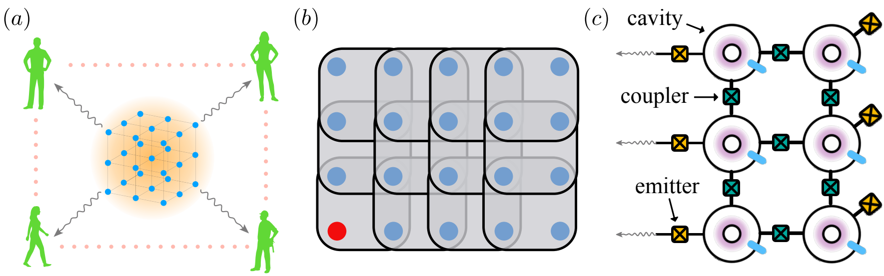

Fig. 1: (a) Generate and distribute photonic MPS with a Rydberg atomic array. (b) Plaquette projected entangled-pair states (p-PEPS). (c) Generate a subclass of photonic p-PEPS with coupled cavities and transmons.

References

[1] Z.Y. Wei, D. Malz, A.G.Tudela, J.I.Cirac, Physical Review Research, 3(2), 023021

[2] Z.Y. Wei, D. Malz, J.I.Cirac, arXiv:2109.06781

[3] Z.Y. Wei, J.I.Cirac, D. Malz, arXiv:2107.05873

*Presenting author: zhiyuan.wei@mpq.mpg.de