Largest-ever 3-D quantum chip for boosting analog quantum computing

May 14 2018

Chinese scientists Xianmin Jin and his colleagues from Shanghai Jiao Tong University have successfully fabricated the largest-scaled quantum chip and demonstrated the first two-dimensional quantum walks of single photons in real spatial space, which may provide a powerful platform to boost analog quantum computing for quantum supremacy.

Since early last year, IBM, Google, Intel and rivals have competed to set new records on the achieved number of qubits in quantum computer development. However, universal quantum computers are far from feasible until error correction and full connections between the increasing number of qubits can be realized. In contrast, analog quantum computers, or quantum simulators, can be built in a straightforward way to solve practical problems directly without error correction, and potentially beat the computational power of classical computers in the near future.

As a powerful and straightforward approach to analog quantum computing, the quantum walk in a two-dimensional array maps certain computing tasks into the coupling matrix of the quantum paths, and provides efficient solutions to even classically intractable problems. Prominent quantum advantages are achievable as long as the scale of quantum systems goes above a considerably large level. Xianmin Jin et al are now able to fabricate a three-dimensional photonic chip with a scale up to 49×49 nodes using a technique called femtosecond direct writing. It is the largest-scaled chip reported so far that allows for the realization of this two-dimensional quantum walk in real spatial space, and allows

researchers to explore many new quantum computing tasks.

This work demonstrates that the dimension and scale of quantum system can be employed as new resources for boosting quantum computing power. During the past two decades, increasing the photon number has posed a challenge, resulting in probabilistic generation of single photons and multiplicative loss. This ingenious alternative method of increasing the external physics dimension and complexity of the quantum evolution system may accelerate future analog quantum computing.

More information: Hao Tang et al. Experimental two-dimensional quantum walk on a photonic chip, *Science Advances* (2018). DOI: 10.1126/sciadv.aat3174

Provided by Shanghai Jiao Tong University