Optical quantum computers with quantum teleportation

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We did the first experiment of unconditional quantum teleportation at Caltech in 1998 [1]. Then we did various related experiments like quantum teleportation network [2], teleportation of Schrödinger’s cat state [3], and deterministic quantum teleportation of photonic qubits [4]. We invented the scheme of teleportation-based quantum computing in 2013 [5]. In this scheme, we can multiplex quantum information in the time domain and we can build a large-scale optical quantum computer only with four squeezers, five beam splitters, and two optical delay lines [6]. For universal quantum computing with this scheme, we need a nonlinear measurement and we invented the efficient way [7]. We recently succeeded in the realization [8]. Our present goal is to build a super quantum computer with 100GHz clock frequency and hundred cores, which can solve any problems faster than conventional computers without efficient quantum algorithms like Shor’s algorithm. Toward this goal we started to combine our optical quantum computer with 5G technologies [9]. For the realization of fault-tolerance with our optical quantum computers, we use Gottesman-Kitaev-Preskill (GKP) qubits [10]. We recently succeeded in the generation [11] and invented an efficient way for the generation [12]. We built a real machine of optical quantum computer in Riken and put it on the cloud. We launched a new start-up company OptQC in September, 2024 which is working on building a large-scale neural network based on optical quantum computers.

References

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