Quantum random-walk search algorithm on a photonic chip

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We experimentally demonstrate the quantum random-walk search algorithm (Shenvi-Kempe-Whaley algorithm) on a graph of 2^3 nodes (a 3-dimensional hypercube) using integrated photonics. The quantum circuit is designed and fabricated on a photonic chip for an oracle search on a database of effectively eight objects. Using path-encoded single photons heralded from the waveguide-based parametric down-conversion, the performance of the photonic chip is characterized to have an overall fidelity of 99%. Our work may have applications in quantum-random-walk-based quantum information processing with integrated photonics.