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On-chip genuine three-qubit entanglement from a deterministic source

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Multi-photon entangled state is the key ingredient in realizing measurement-based quantum computing. The current proposals for universal quantum computation require simultaneously high generation rates, high fidelity, and low loss, which are beyond the capability of the current experimental systems. In this work, we address this critical problem by demonstrating the on-chip deterministic generation of a three-qubit state. Our work bridges the gap toward an ideal platform where photons are collected with almost unity efficiency on-chip. Using a quantum dot embedded in a photonic crystal waveguide, we charge it deterministically with a single electron spin. We control the electron spin environment by narrowing the nearby nuclear spin distribution, thus improving the T2* time by a factor of 10. Moreover, we demonstrate genuine three-qubit entanglement, which consists of an electron spin and two indistinguishable photons. Our work constitutes a key step toward the next-generation device where the criteria for a fully-fledged photonic quantum computer can be fulfilled.

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