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An Elementary Quantum Network of Single Atoms in Optical Cavities ANDREAS REISERER, STEPHAN RITTER, CHRISTIAN NOELLEKE, CAROLIN HAHN, ANDREAS NEUZNER, MANUEL UPHOFF, MARTIN MUECKE, EDEN FIGUEROA, JOERG BOCHMANN, GERHARD REMPE, Max-Planck-Institute of Quantum Optics, Garching, Germany — A quantum network consists of stationary nodes that are connected by quantum channels. Besides fundamental interest, such a quantum network is a prerequisite for distributed quantum computing architectures and has numerous applications in quantum communication. Here we present a prototype of such a quantum network based on two single atoms that are trapped in remote optical cavities and connected by an optical fiber link. The atom-cavity systems form universal quantum nodes in the sense that they are capable of sending, receiving, processing, storing and releasing quantum information that is encoded in the polarization of single photons. Via the temporal control of a coherent dark state we demonstrate the faithful transfer of a quantum state from one atom to the other. This is accomplished in the conceptually most fundamental way: by the coherent emission and absorption of a single photon. In the same way, we create a maximally entangled state between the two nodes that are in independent laboratories and separated by 20m. Due to its high efficiency and high fidelity ($\sim$0.9) our cavity-based approach paves the way towards large-scale quantum networks and their applications.

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