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Mapping photonic entanglement into and out of a quantum memory[1] HUI DENG, KYUNG S. CHOI, JULIEN LAURAT, H. JEFF KIMBLE, California Institute of Technology — Recent developments of quantum information science critically rely on entanglement. In particular, scalable quantum networks require capabilities to create, store, and distribute entanglement among distant nodes via photon channels. Atomic ensembles can serve as such nodes. In the photon counting regime, heralded entanglement between atomic ensembles has been demonstrated via probabilistic protocols. However, an inherent drawback of such protocols is the compromise between the fidelity of entanglement and its preparation probability, which hinders the schemes' scalability. Here we present a protocol where entanglement between atomic ensembles is created by coherent mapping of photonic entanglement. By splitting a single-photon and subsequent state transfer, we separate the generation of entanglement and its storage, enabling efficient scaling for high-fidelity quantum communication. After a programmable delay, chosen at 1us, the stored entanglement is mapped back into photon modes with an overall efficiency of 17%. With improved retrieval efficiency and memory time, along with the development of on-demand single photon sources, our protocol enables the deterministic generation, storage, and distribution of entanglement among remote quantum memories for scalable quantum networks.

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