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High teleportation rates using Rydberg-based quantum repeaters

NEAL SOLMEYER, QUDSIA QURAISHI, Army Research Laboratory, 2800 Powder Mill Rd., Adelphi, MD 20783 — Quantum networking over long distances may be achieved using repeater protocols to generate entanglement between memory nodes [Duan *et al.,* Nature **414,** 413 (2001)]. Typically, long-lived memories have low entanglement generation rates. Neutral atom memories can be long-lived, emit at visible wavelengths and can be collectively excited leading to directionally emitted entangled photons. Here, we propose a simplified Rydberg-based quantum repeater based on recent work [Zhao *et al.,*PRA **81**,052329 (2010)], where we reduce the number of ground states used for entanglement generation and use only one ensemble at each node, reducing the required resources. The collective excitation allows for deterministic memory generation that is mapped into a directionally emitted photonic qubit without the use of a high finesse optical cavity. We demonstrate a protocol between multiple memories stored within a single ensemble to implement a two-qubit gate. Additionally, we predict teleportation rates of 1 Hz without the use of a high finesse optical cavity, which could be increased to kHz if efficiencies are improved over the currently realized values. We plan to explore these protocols in ultra-cold ensemble of neutral ^{87}Rb atoms and are currently building this setup.

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