Abstract Submitted
for the DAMOP18 Meeting of
The American Physical Society

Carving of atomic Bell states with an optical cavity STEPHAN WELTE, BASTIAN HACKER, SEVERIN DAISS, STEPHAN RITTER, LIN LI, GERHARD REMPE, Max Planck Institute of Quantum Optics — Optical resonators constitute an ideal platform to mediate interactions between distant matter qubits [1]. In a quantum network architecture, this is achieved by the exchange of photons between the network nodes, and in this way enables the generation of remote entanglement. Here we demonstrate how photons can likewise be used to generate local entanglement between matter qubits, neutral atoms in our case, in the same network node [2]. Such entangled states are a valuable resource in many quantum communication protocols. We implemented two protocols [3], both relying on the reflection of polarized light from the atom-resonator system. Detection of a polarisation flip heralds the entanglement and postselection allows us to remove parts of the combined two-atom wave function, a method called carving. We achieve fidelities with the ideal Bell states of up to 90%. Our entangling mechanism can be applied to any matter qubit with a closed optical transition and no individual addressing is required. [1] A. Reiserer, G. Rempe, Rev. Mod. Phys. 87, 1379 (2015). [2] S. Welte, B. Hacker, S. Daiss, S. Ritter, G. Rempe, Phys. Rev. Lett. 118, 210503 (2017). [3] A. Soerensen, K.Moelmer, Phys. Rev. Lett. 90, 127903 (2003).

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Date submitted: 26 Jan 2018 Electronic form version 1.4