

Abstract Submitted  
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**Preparation and control of neutral atom ensemble qubits using Rydberg interactions**<sup>1</sup> CHRISTOPHER YOUNG, MINHO KWON, PEIYU YANG, PRESTON HUFT, BRANDON RADZOM, MATTHEW EBERT, THAD WALKER, MARK SAFFMAN, Department of Physics, University of Wisconsin - Madison — Ensemble qubits with strong coupling to photons and resilience against single atom loss are promising candidates for building quantum networks. We report on progress towards high fidelity preparation and control of ensemble qubits using Rydberg blockade. Our previous demonstration of ensemble qubit preparation at a fidelity <60% was possibly limited by Rydberg blockade leakage due to uncontrolled short range atom pair separation. We show progress towards ensembles with a blue-detuned 1-D lattice on top of the existing red-detuned dipole trap, which will suppress unwanted Rydberg interactions by imposing constraints on the atomic separation. We study the effect of lattice insertion on the fidelity of ensemble state preparation and Rydberg-mediated gates. Studies of cooperative scattering from a 1D atomic array will also be presented.

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