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Towards Quantum Information Processing Using Rydberg Blockade[1]

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Neutral atoms show great promise for use as qubits for quantum information processing. Long coherence times combined with the large interactions available using Rydberg states lead to the possibility of high fidelity quantum operations. In addition the long range of the Rydberg blockade mechanism allows for interactions between many qubits leading to significant speedups in some quantum algorithms. This has been specifically shown for Grover's algorithm where a single iteration can be reduced to 6 pulses [1]. In addition initial studies of error rates for this algorithm show that up to 15 qubits can be used in a single register, and that multiple registers could be combined to increase the effective number of qubits. Recent experimental progress using Rydberg blockade has entangled two qubits [2,3] and detailed analysis shows that current experiments are dominated by technical errors [4]. Progress towards improved quantum gates on a new experimental apparatus that has been designed to reduce these technical errors and have greater scalability will be presented.

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[2] Wilk, T., et al. *Phys. Rev. Lett.* **104**, 010502 (2010).
[3] Zhang, X. L., et al. *Phys. Rev. A* **82**, 030306(R) (2010).
[4] Zhang, X. L., et al. arXiv:1201.6370 (2012).

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