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Robust Entangling Quantum Logic Gates Using Adiabatic Rydberg Dressing ANUPAM MITRA, PABLO POGGI, IVAN DEUTSCH, Center for Quantum Information and Control, University of New Mexico — The Rydberg blockade mechanism has been used to entangle two qubits encoded in the hyperfine ground manifold of neutral atoms. Thermal motion of atoms limits the gate fidelity in protocols involving resonant excitation to Rydberg states, as the internal atomic states and external motional states become entangled, leading to different random phases accumulated by the computational basis states. An adiabatic Rydberg-dressing protocol provides intrinsic robustness against thermal Doppler inhomogeneities by suppressing the mixing of bright and dark states, and a common-mode cancellation of single-atom and two-atom Doppler shifts. Moreover, one can overcome additional residual errors by combining adiabatic dressing with the tools of microwave (or Raman) based quantum control. We study a variety of protocols and pinpoint the major sources of error and how to cancel them. Entangling gate fidelities of 0.99 are well within reach and higher fidelities are possible if Rydberg lifetimes can be increased.

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