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Geometric Unitary Gates in Cold Atom Ensembles on an Atom Chip YICONG ZHENG, TODD BRUN, University of Southern California, QUANTUM COMMUNICATION TEAM — We propose a feasible scheme to achieve quantum computation based on geometric manipulation of ensembles of atoms, and analyze it for neutral rubidium atoms magnetically trapped in planoconcave microcavities on an atom chip. The geometric operations are accomplished by optical excitation of a single atom into a Rydberg state in a constant electric field. Strong dipole-dipole interactions and incident lasers drive the dark state of the atom ensembles to undergo some specified cyclic evolutions that realize a universal set of quantum gates. Such geometric manipulation turns out naturally to protect the qubits from the errors induced by non-uniform laser illumination as well as cavity loss. The gate performance and decoherence processes are analyzed by numerical simulation.

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