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Entanglement of Qubits Encoded in Cesium Atoms via Rydberg Dressing YUAN-YU JAU, AARON HANKIN, Sandia National Laboratories, TYLER KEATING, IVAN DEUTSCH, University of New Mexico, GRANT BIEDERMANN, Sandia National Laboratories — Neutral-atom qubits are normally encoded in the ground-state sublevels for long coherent operations, but strong, tunable long-range interactions between ground-state neutral atoms are difficult to achieve. By applying off-resonant Rydberg excitation lasers to the atoms, we can in principle generate Rydberg-dressed, AC-Stark shifted qubit or spin states. Owing to the electric dipole-dipole interactions (EDDI) between atoms in the Rydberg states, different collective qubit states can acquire different AC Stark shifts, which cause effective interactions between qubits. On the other hand, transition blockades between collective qubit states also occur. We have experimentally demonstrated a strong ground-state interaction strength ($\sim$ MHz) between the two singly trapped, Rydberg-dressed Cs atoms. With a transition blockade between the two-qubit states due to Rydberg dressing, we are able to produce Bell-state entanglements of with >80% fidelity excluding the atom loss event. The two-atom survival (no loss) probability is 74% with about 10 Hz data rate. This gives us about 6 entangled qubit pair per second.

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