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Single atoms in optical tweezers for quantum computing

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Our group is interested in neutral atom quantum computing. With this goal in mind, we have recently shown how a single rubidium atom trapped in an optical tweezer can be used to store, manipulate and measure a qubit. I will detail in this talk how we trap and observe a single atom in an optical tweezer created by focusing a far-off resonant laser down to a sub-micron waist. Our qubit is encoded on the $|0\rangle = |F=1, M=0\rangle$ and $|1\rangle = |F=2, M=0\rangle$ hyperfine sublevels of a rubidium 87 atom. We initialize the qubit by optical pumping. We read the state of the qubit using a state selective measurement limited by the quantum projection noise. We perform single qubit operation by driving a two-photon Raman transition. We have measured the coherence time of our qubit by Ramsey interferometry. After applying a spin-echo sequence, we have found an irreversible dephasing time of about 40 ms. To perform a computation, a feature is the ability to perform a gate between two arbitrary qubits of the register. As a first step, we have demonstrated a scheme where the qubit is transfered between two tweezers with no loss of coherence and no change in the external degrees of freedom of the atom. We have then moved the atom over distances typical of the separation between atoms in an array of dipole traps, and shown that this transport does not affect the coherence of the qubit. Finally, I will present our progress towards entangling two atoms, a key ingredient towards building a two-qubit gate.