Single-Atom Trapping in Optical Tweezers for Quantum Simulation

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We have successfully trapped individual strontium-88 atoms in optical tweezers, marking a significant step toward the realization of a scalable quantum simulator. Our approach leverages a combination of blue and red magneto-optical traps to cool the atoms to microkelvin temperatures before loading them into an array of tightly focused optical tweezers. Currently, we use acousto-optic deflectors to generate the tweezer array. However, we are implementing a spatial light modulator to improve trap depth uniformity, which will enhance the stability and homogeneity of atomic confinement. This transition will enable more precise control over atomic interactions, paving the way for scalable quantum simulations and entanglement generation via controlled Rydberg interactions. Future directions include atom rearrangement, high-fidelity state preparation, and spin transport physics.