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**Laser cooling atoms to indistinguishability: Atomic Hong-Ou-Mandel interference and entanglement through spin exchange**

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Motional control of neutral atoms has a rich history and increasingly interest has turned to single-atom control. In my thesis work, we created a platform to individually prepare single bosonic atoms in highly pure quantum states, by developing methods to laser cool single atoms to the vibrational ground state of optical tweezer traps. Applying this toolset, we observe the atomic Hong-Ou-Mandel effect when we arrange for atom tunneling to play the role of a balanced beam splitter between two optical tweezers. In another experiment, we utilize spin exchange to create entanglement, which we then verify after spatially separating the atoms to observe their non-local correlations. Merging these results with our recent demonstration of deterministic loading of atomic arrays, our results establish the concept of quantum gas assembly, which could be applied to a variety of systems ranging from the production of single dipolar molecules to the assembly of low-entropy arrays of atoms.