Abstract

We excite a beam of 2S metastable helium atoms to Rydberg States (n=15-50) using Stimulated Rapid Adiabatic Passage (STIRAP). It is done as atoms pass through two, slightly overlapped laser beams at ~796 nm and ~389 nm in the counter-intuitive order, coupled by the intermediate 3P state.

What is STIRAP?

STIRAP is used to excite atoms to Rydberg states with n=15-50. The theory in our experiment describes how STIRAP can achieve 100% population transfer. This is possible because in the system we effectively do not populate the intermediate state if we use the counter-intuitive order. The counter-intuitive order means that the laser beam associated with the 2> to 3> state transition interacts with the atomic beam before the beam associated with the 1> to 2> transition. We excite an atomic beam of metastable-ground state Helium (He*) to Rydberg states through an intermediate state.

Helium Energy Levels

STIRAP was used to excite atoms to Rydberg states with n=15-50. The theory in our experiment describes how STIRAP can achieve 100% population transfer. This is possible because in the system we effectively do not populate the intermediate state if we use the counter-intuitive order. The counter-intuitive order means that the laser beam associated with the 2> to 3> state transition interacts with the atomic beam before the beam associated with the 1> to 2> transition. We excite an atomic beam of metastable-ground state Helium (He*) to Rydberg states through an intermediate 3P state.

Detection Systems

Theory suggests that we should be able to achieve 100% population transfer to the Rydberg state. Experimental results have only achieved ~50% population transfer. We believe this is due to the transverse velocity spread of atoms such that they are Doppler Shifted out of resonance. Recent experiments have been conducted using optical molasses to decrease this velocity spread.

Conclusion

We excite a beam of 2S metastable helium atoms to Rydberg States (n=15-50) using Stimulated Rapid Adiabatic Passage (STIRAP). It is done as atoms pass through two, slightly overlapped laser beams at ~796 nm and ~389 nm in the counter-intuitive order, coupled by the intermediate 3P state.