Stony Brook University
The Graduate School

Doctoral Defense Announcement

Abstract

Excitation of Helium to Rydberg States Using STIRAP

By

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Driving atoms from an initial to a final state of the same parity via an intermediate state of opposite parity is most efficiently done using STIRAP, because it does not populate the intermediate state. For optical transitions this requires appropriate pulses of light in the counter-intuitive order – first coupling the intermediate and final states.

We populate Rydberg states of He (n=12~35) in a beam of average velocity 1070 m/s by having them cross two laser beams in a tunable dc electric field. The "red" light near λ =792~830 nm connects the 3^3P states to the Rydberg states and the "blue" beam of λ =389 nm connects the metastable 2^3S state atoms emitted by our source to the 3^3P states. By varying the relative position of these beams we can vary both the order and the overlap encountered by the atoms. We either vary the dc electric field and fix the "red" laser frequency or vary the "red" laser frequency and fix the dc electric field to sweep across Stark states of the Rydberg manifolds.

Several mm downstream of the interaction region we apply the very strong bichromatic force on the $2^3S \rightarrow 2^3P$ transition at λ =1083 nm. It deflects the remaining 2^3S atoms out of the beam and the ratio of this signal measured with STIRAP beam on and off provides an absolute measure of the fraction of the atoms remaining in the 2^3S state. Simple three-level models of STIRAP all predict 100% excitation probability, but our measurements are typically around half of this, and vary with both *n* and *l* of the Rydberg states selected for excitation by the laser frequency and electric field tuning on our Stark maps.

An ion detector readily detects the presence of Rydberg atoms. We believe that the observed signals are produced by black-body ionization at a very low rate, but sufficient to ionize about 0.5~1% of the atoms in a region viewed by our detector. Many measurements provide support for this hypothesis.

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