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Absolute Efficiency for STIRAP Excitation of Rydberg States[1]

X. LU, Y. SUN, H. METCALF, Stony Brook University — We have developed a method for measuring the absolute efficiency for two step STIRAP excitation of Rydberg states. A beam of metastable 2^3S state He atoms crosses two laser beams at 90^o that can be displaced to vary their order of encounter by the atoms. The lower transition connects to the 3^3P state via $\lambda = 389$ nm light and the upper one to the n, ℓ states via $\lambda = 785$ - 815 nm ($n \sim 13-45$). In the STIRAP process, atoms encounter the red light before the blue. Data from an ion detector enables us to make Stark maps that agree well with calculated energies. Several mm downstream of the interaction region we apply the very strong bichromatic force[2] on the $2^3\text{S} \rightarrow 2^3\text{P}$ transition at $\lambda = 1083$ nm. It deflects the remaining 2^3S atoms out of the beam and the ratio of this signal measured with STIRAP beam on or off provides an absolute measure of the fraction of the atoms remaining in the 2^3S state (most Rydberg atoms don't decay to 2^3S during this short flight distance). Simple three-level models of STIRAP all predict 100% excitation probability, but our measurements are typically less than 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. We are surprised by this result.

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[2]M. Partlow et al., Phys. Rev. Lett. **93** 213004 (2004) and its references.

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