A 3D ELECTROSTATIC TRAP FOR RYDBERG ATOMS AND MOLECULES

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Recent progress in the development of methods by which to decelerate and manipulate the translational motion of Rydberg atoms and molecules in the gas phase using static and time-varying inhomogeneous electric fields [1] has led to the experimental realisation of Rydberg atom optics elements including a lens [2], a mirror [3] and a two-dimensional trap [4]. These experiments exploit the very large electric dipole moments associated with Rydberg Stark states, and have demonstrated the possibility to stop a seeded, pulsed, supersonic beam of atomic hydrogen travelling with an initial velocity of 700 ms^{-1} within 2 mm ($\sim 5\ \mu$s) using electric fields of only a few kVcm^{-1}.

With the goal of achieving complete control of a cloud of Rydberg atoms or molecules in three-dimensions, we have recently designed and constructed a three-dimensional electrostatic trap for these particles [5]. The design of this trap will be presented along with the results of a series of experiments in which we have used the trap to confine, in three dimensions, a cloud of atomic hydrogen Rydberg atoms in states of principal quantum number around $n = 30$. The dynamics of the Rydberg atoms in the trap have been investigated by pulsed field ionisation and imaging techniques. Under favourable conditions, trapping times on the order of 150 μs have been observed. An important conclusion from this work is that as the trapping times closely match the fluorscence decay time to the $^2S_{1/2}$ ground state, cold stationary samples of ground state atoms can be produced following Rydberg Stark deceleration.

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