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Demonstration of a three-dimensional trap for state-selected Rydberg atoms STEPHEN HOGAN, FREDERIC MERKT, ETH Zurich, Switzerland — 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 has led to the experimental realization of Rydberg atom optics elements including a lens, a mirror and a two-dimensional trap. 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 traveling with an initial velocity of 700 ms^{-1} within 3 mm and 5 μs 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. 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 with principal quantum numbers around $n = 30$. The dynamics of the Rydberg atoms in the trap have been investigated by pulsed field ionization and imaging techniques. Under favorable conditions, trapping times on the order of 150 μs have been observed, corresponding to the radiative lifetimes of the excited states.

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