A transmission-line decelerator for atoms in high Rydberg states

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A transmission-line decelerator, based upon the continuous motion of a set of three-dimensional electric traps above a planar array of surface-based electrodes, has been developed and demonstrated experimentally for the manipulation of samples in high Rydberg states. This device is ideally suited for accelerating, decelerating and trapping helium atoms initially travelling in fast (∼1950 m/s) pulsed supersonic beams.

The decelerator design comprises an array of miniature metallic electrodes imprinted on an insulating substrate. These electrodes are located between two ground planes and therefore represent a segmented electrical transmission line. Deceleration is achieved by applying a set of pre-programmed oscillating electrical potentials to this array of electrodes, in a manner similar to that used in other chip-based Stark decelerators [1–3].

Our surface-based decelerator exploits the very large electric dipole moments, on the order of 10000 D, associated with Rydberg states of high principal quantum number, and can be readily combined with recently developed transmission-line guides [4] for comprehensive control of the translational motion of Rydberg atoms and molecules close to surfaces.

In general, surface-based devices for manipulating the translational motion and internal quantum states of Rydberg atoms and molecules have applications in hybrid approaches to quantum information processing involving Rydberg atoms and microwave circuits [5], in studies of Rydberg atom/molecule-surface interactions [6], and chemistry at low temperatures [7].

References

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