Coherent manipulations of atomic wavefunctions in optical lattices

VLADYSLAV IVANOV, University of Washington, A. ALBERTI, M. SCHIOPOPO, G. FERRARI, LENS, Italy, G.M. TINO, University of Florence, Italy, LENS TEAM — We report on the realization of dynamical control of transport for ultra-cold $^{88}\text{Sr}$ atoms loaded in accelerated and amplitude-modulated optical lattices. Cold atoms trapped in vertical optical lattices give rise to localized states, the Wannier-Stark states. Delocalization can be recovered by introducing a resonant coupling among neighboring lattice sites. We demonstrated this by applying a modulation either to the phase or the amplitude of the lattice potential. Atomic samples loaded into modulated vertical optical-lattice potentials exhibit a resonant delocalization dynamics arising from intraband transitions among Wannier-Stark levels [1]. We demonstrate the coherent control of the spatial extent of atomic wavefunctions by reversibly stretching and shrinking the wavefunctions over a distance of more than one millimeter [2]. Furthermore we tailor the dispersion law of atomic traveling wave-packets and show the ability to reversibly switch between localization regime and tunneling one. From this a novel atom mirror in optical lattices is demonstrated by reversing the group velocity of the atoms.