Quantum resonances and rectification of driven cold atoms in optical lattices

S. Denisov, L. Morales-Molina, S. Flach

Abstract

Classical Hamiltonian ratchets have been recently successfully realized using cold atoms in driven optical lattices. Here we study the current rectification of the motion of a quantum particle in a periodic potential exposed to an external ac field. The dc current appears due to the desymmetrization of Floquet eigenstates, which become transporting. Quantum dynamics enhances the dependence of the current on the initial phase of the driving field. By changing the laser field parameters which control the degree of space-time asymmetry, Floquet eigenstates are tuned through avoided crossings. These quantum resonances induce resonant changes of the resulting current. The width, strength and position of these quantum resonances are tunable using control parameters of the experimental realization with cold atoms.