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Photo-induced Tomonaga-Luttinger liquid in a one-dimensional Mott insulator

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We theoretically study the metallic state induced by strong electric fields applied to a one-dimensional Mott insulator. The time-dependent density matrix renormalization group method is used to calculate the nonlinear optical conductivity where we have found an emergence of metallic states with linear dispersions within the energy gap. The charge velocity is renormalized by interaction which indicates that the photo-doped carriers behave collectively as in the equilibrium Tomonaga-Luttinger liquid. A non-equilibrium phase diagram for the photo-induced insulator-to-metal transition is then proposed. The mechanism of photo-doping is further studied by an effective Dirac model, where the Floquet method is employed to incorporate the effect of strong electric fields.

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Vortex Pump for Dilute Bose-Einstein Condensates

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The formation of vortices by topological phase engineering has been realized experimentally to create the first two- and four-quantum vortices in dilute atomic Bose-Einstein condensates. We consider a similar system, but in addition to the Ioffe-Pritchard magnetic trap we employ an additional hexapole field. By controlling cyclically the strengths of these magnetic fields, we show that a fixed amount of vorticity can be added to the condensate in each cycle. In an adiabatic operation of this vortex pump, the appearance of vortices into the condensate is interpreted as the accumulation of a local Berry phase. Our design can be used as an experimentally realizable vortex source for possible vortex-based applications of dilute Bose-Einstein condensates. [Möttönen et al., Phys. Rev. Lett. 99, 250406 (2007)]