Abstract

While the study of ultracold atoms in time-independent optical lattice potentials already has matured into a major area of current research, the investigation of matter waves in time-periodically shaken optical lattices still lies in its infancies. When the forcing amplitude reaches the nonperturbative regime not covered by linear response theory, the ac-Stark effect considerably modifies the original band structure and thus introduces various effects even on the single-particle level which have no counterpart in undriven lattices. The experimental and theoretical challenge now is to extend our understandig of such phenomena to the many-body level, in order to achieve coherent control of mesoscopic matter waves, and thus to realize systems which have no immediate analog in traditional solid-state physics. The observation of both dynamic localization and coherent control of the Mott insulator transition by the Pisa group are promising first steps in this direction. In this talk I will outline a theoretical scheme, based on Floquet's theorem, which yields a particularly transparent approach to such dynamical problems, and sketch possible future developments.