

CQD Kolloquium

Support in a Many-Body Wannier-Stark Setup

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Ultra-cold atoms in optical lattices

Ultra-cold atoms in optical lattices are systems showing rich and complex behaviour

- Bose-Einstein condensates are easily created and loaded into optical lattices

- physical parameters can be controlled almost at will and many different Hamiltonians realized

- quantum effects can be studied in detail

We focus on ultra-cold bosons in deep optical lattices, which allow to realize the Wannier-Stark Hamiltonian for interacting particles.

Block, Dalibard and Jaksch, Rev. Mod. Phys. 80, 463 (2008)



Methods of investigation

We use different theoretical methods to investigate subtle aspects of Wannier-Stark problems and the influence of different observables, the disorder or interaction. These methods are:

- algebraic methods

- Floquet-Lowenstein algorithms

- full diagonalization and matrix exponentiation

- variational approaches

- exact simplified systems results

- exact effective models

- compare results with explicit matrix numerics (DMRG)

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On the band coupling: avoided crossings

→ Single particle Wannier-Stark spectrum

- the tilt F is the control parameter

- single particle avoided crossing at sites

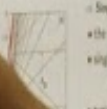
$$E_{\pm} = \frac{1}{2} \left(\epsilon_{\pm} \pm \sqrt{\epsilon_{\pm}^2 - 4|t_{\pm}|^2} \right)$$

- typical exchange of character at F_c

- connecting rate $\sim |t_{\pm}|$ ladder

$$|t_{\pm}| = \sqrt{t_{\pm}^2 + \epsilon_{\pm}^2}$$

Maniákis



On the dynamics: EF's diffusion

Through F_c ...

- many-body avoided crossing is visible at single-particle level

- dispersion relation: $E(k) = \epsilon_{\pm} + t_{\pm} e^{ik}$

$$E_{\pm}(k) = \frac{1}{2} \left(\epsilon_{\pm} \pm \sqrt{\epsilon_{\pm}^2 - 4|t_{\pm}|^2 \cos^2(k)} \right)$$

The total spectrum (EF) is

$$E_{\pm}(k) = \epsilon_{\pm} + t_{\pm} e^{ik}$$

diffusion properties are

$$D_{\pm} = \frac{1}{2} \left(\frac{t_{\pm}^2}{\epsilon_{\pm}^2} + \frac{1}{2} \right)$$

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„Poster Session“

Mittwoch, 10.12.2014

17:30 Uhr

Kirchhoff-Institut, INF 227, SR 1.403