127 Transport in linear chains under periodic perturbations

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In recent years there has been remarkable progress in experimental techniques, making possible the implementation of quantum systems with a high degree of controllability. In particular, in experiments with ultracold atoms it is possible not only to control the dimensionality of the system, but also to precisely tune external potentials and interactions among particles.[1] We present a theoretical model to obtain steady state solutions for a linear chain which is periodically perturbed in one site.

We want to consider a one dimensional chain with periodic boundary conditions. The corresponding Hamiltonian is given by a standard tunneling term and a periodic perturbation of amplitude μ_0 and frequency Ω at site 0:

$$H = -J \sum_i (c_i^\dagger c_{i+1} + c_{i+1}^\dagger c_i) - \mu_0 \cos(\Omega t) c_0^\dagger c_0 \tag{1}$$

Thanks to the periodicity in time of the Hamiltonian, one can apply the Floquet theorem to simplify the problem, very similar to the approach used for periodic lattices.[2] This leads to characteristic periodic functions with corresponding quasi-energies. It is sufficient to consider only the first "Brillouin" zone. We solve the problem for frequencies with $\Omega > 4J$ and quasi-energies close to the middle of the Brillouin zone. One unbound state which is completely delocalized and infinite bound states localized at the impurity emerge. We obtain recursive relations for the coefficients of the corresponding states which we solve numerically and give steady eigenstate solutions. These give insight to interesting properties such as the reflection coefficient R (Fig. 1) which is given by the ratio of the probability currents of the incident wave j_{inc} and reflecting wave j_{refl}:

$$R = \frac{|j_{refl}|}{|j_{inc}|} \tag{2}$$

The findings are compared to other theoretical approaches. We will discuss how the results obtained by Floquet predict the outcome of various experimental set-ups in periodically perturbed linear chains. Future work will involve the treatment of a greater spectrum of parameter combinations.

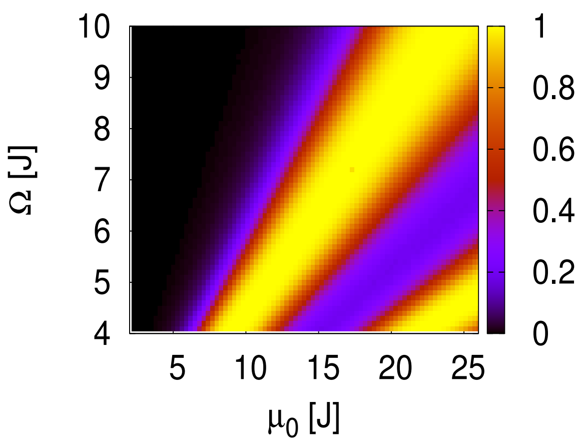

Fig. 1 *Square of the reflection coefficient R^2 as a function of the amplitude μ_0 and frecueny Ω of the perturbation.*

References

[1] Bloch, I., Dalibard, J., Zwerger, W., Reviews of Modern Physics, **80(3)**, 885 (2008).
[2] Grifoni and P. Haenggi, Phys. Rep. **304**, 229-358 (1998).