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Abstract

Condensed Matter

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Non-equilibrium almost-stationary states and linear response for gapped non-interacting quantum systems

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We prove the validity of linear response theory at zero temperature for gapped infinitely extended quantum systems within the one-particle approximation. A gapped Hamiltonian, which is not necessarily periodic, is perturbed by switching on adiabatically in time a constant electric field of intensity $\varepsilon \ll 1$, modelled by a linear potential. It is shown that the initial Fermi projection evolves adiabatically into *non-equilibrium almost-stationary state* (NEASS), once the perturbation, which closes immediately the spectral gap of the unpertubed Hamiltonian, is turned on. We prove formulas for linear and higher order response coefficients, including the conductivity tensor.

We follow the strategy implemented in [2], but for both discrete and continuum models. Two new technical difficulties occur: to establish the trace class property and to deal with domain issues of some relevant unbounded operators (e.g. the domain of the perturbed Hamiltonian does depend on time). Finally, we provide a rigorous comparison between our approach, in which a uniform electric field is modelled by a linear (unbounded) potential, and the more traditional one where a time-dependent gauge transformation is performed (e.g. [1]).

References

[1] J.-M. Bouclet, F. Germinet, A. Klein, and J.H. Schenker, Linear response theory for magnetic Schrödinger operators in disordered media. *J. Funct. Anal.* **226** (2005), 301–372.

[2] S. Teufel, Non-equilibrium almost-stationary states and linear response for gapped quantum systems. *Commun. Math. Phys.* (2019). https://doi.org/10.1007/s00220-019-03407-6.