Quantum transport in the presence of disorder

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Les Houches - October 2017

Outline

Transport in disordered systems can be strongly affected (enhanced, diminished or completely inhibited) by quantum interferences between multiply scattered waves. Cold atomic gases offer unique opportunities to study these effects. In the lectures, I will mainly concentrate on the regime of non-interacting particles (one-body physics) where many phenomena are well understood. In the last lecture, I will try to summarize the status of a very rapidly evolving field dubbed many-body localization.

- Lecture 1: **Introduction, basic concepts: scattering and transport mean free path, ballistic and diffusive motion, weak localization, strong (Anderson) localization**
- Lecture 2: **One-dimensional disordered systems; Quantum theory of transport (very basic)**
- Lecture 3: **Scaling theory of localization**
- Lecture 4: **Coherent backscattering**
- Lecture 5: **Self-consistent theory of localization; Many-body localization**

Some references (links should be clickable)

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- B. L. Altshuler and P. A. Lee, *Disordered electronic systems*, Physics Today **41**, 36-44 (1988).
- B. Kramer and A. MacKinnon, *Localization: Theory and Experiment*, Rep. Prog. Phys **56**, 1469 (1993).
- S. Chakravarty and A. Schmid, *Weak localization: the quasiclassical theory of electrons in a random potential*, Phys. Rep. **140**, 193-236 (1986).
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- L. Sanchez-Palencia and M. Lewenstein, *Disordered quantum gases under control*, Nature Phys. **6**, 87 (2010), arXiv: 0911.0629.
- C. Beenakker, *Random matrix theory of quantum transport*, Rev. Mod. Phys. **69**, 731 (1997).
- Special issue of Annalen der Physik on *Many-body localization*, Volume 529, Issue 7 (July 2017)

A collection of Python scripts for simple numerical experiments on disordered quantum systems can be found at http://chaos.if.uj.edu.pl/~delande/Lectures/?numerical-experiments,8