Kwant project

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Week 7: april 1. - april 7.
Topological Anderson Insulator 1.

2019/04/03

1 Schedule for the semester

Table 1: Original schedule

Week	Scheduled Task
feb. 18. - feb. 24.	Installing Kwant & Running an example
feb. 25. - mar. 3.	Reading the documentation & Running more examples
mar. 4 - mar. 10	Reading theory of 2DEG & Writing a 2DEG calculation
mar. 11. - mar. 17.	2DEG constriction in a magnetic field
mar. 18. - mar. 24.	Graphene focusing
mar. 25. - mar. 31.	Mid term report
apr. 1. - apr. 7.	Topological Anderson Insulator/ Majorana fermion 1.
apr. 8. - apr. 14.	Topological Anderson Insulator/ Majorana fermion 2.
easter holiday	-
apr. 22. - apr. 28.	Topological Anderson Insulator/ Majorana fermion 3.
apr. 29. - may 5.	Topological Anderson Insulator/ Majorana fermion 4.
Eötvös/Pázmány days	-
may 13. - may 19.	Final report

Table 2: Status

Week	Scheduled Task
feb. 18. - feb. 24.	Installing Kwant & Running an example ✓
feb. 25. - mar. 3.	Reading the documentation & Running more examples ✓
mar. 4 - mar. 10	Struggling with graphene minimal conductivity - no result
mar. 11. - mar. 17.	2DEG basics & Eigenstates and LDOS calculation ✓
mar. 18. - mar. 24.	2DEG in magnetic field ✓
mar. 25. - mar. 31.	Mid term report
apr. 1. - apr. 7.	Topological Anderson Insulator/ Majorana fermion 1.
apr. 8. - apr. 14.	Topological Anderson Insulator/ Majorana fermion 2.
easter holiday	-
apr. 22. - apr. 28.	Topological Anderson Insulator/ Majorana fermion 3.
apr. 29. - may 5.	Topological Anderson Insulator/ Majorana fermion 4.
Eötvös/Pázmány days	-
may 13. - may 19.	Final report

2 Progress so far

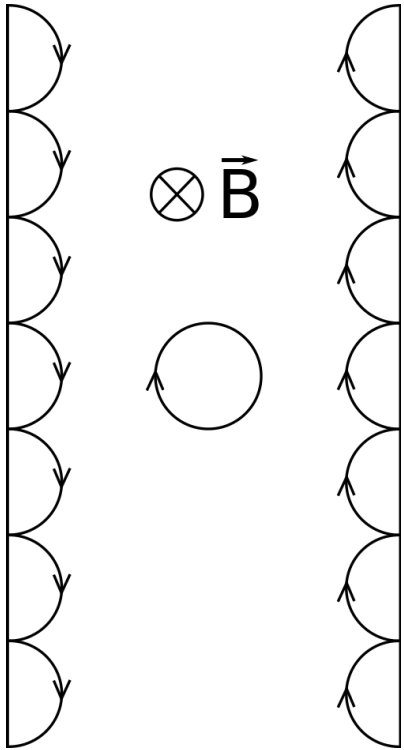
- Installing kwant 1.4.0
- Getting familiar with kwant: Sites, hoppings, builders
- Creating simple and more complex tight-binding systems
- Calculating transmission coefficients between two leads
- Calculating eigenfunctions, local densities of states
- Applying homogeneous magnetic field to a quantum point contact
- Experimenting with graphene: Minimal conductivity near Dirac-point

3 Progress in this week

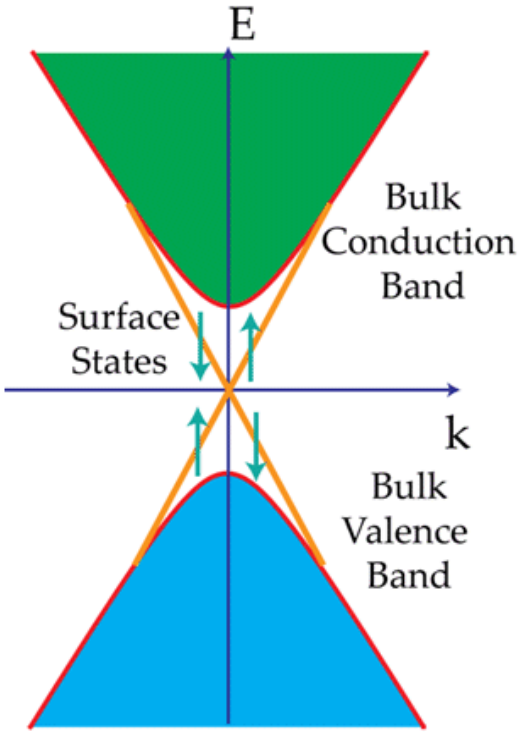
- Extending the report article
- Reading an article: Topological Anderson Insulator https://arxiv.org/abs/0811.3045
- Reading about majorana fermions:
  Introduction to topological superconductivity and Majorana fermions: http://arxiv.org/abs/1206.1736v2,
  Majorana chain in a quantum dot-superconductor linear array: https://arxiv.org/abs/1111.6600,
  Search for Majorana fermions in superconductors: https://arxiv.org/abs/1112.1950
- Trying to understand and reproduce the results described in the article about TAI (https://arxiv.org/abs/0811.3045)

4 Topological insulator theory

- Behave as an insulator in the interior, but have conducting edge states
- Quantum Hall effect creates protected edge states using a strong magnetic field
- Introducing magnetic field breaks time-reversal symmetry



- Another way to create protected edge states is to start from a system with Dirac cones, and open gaps in those
- Graphene is a two-dimensional system which has Dirac cones
- This makes graphene suitable to be used as a topological insulator



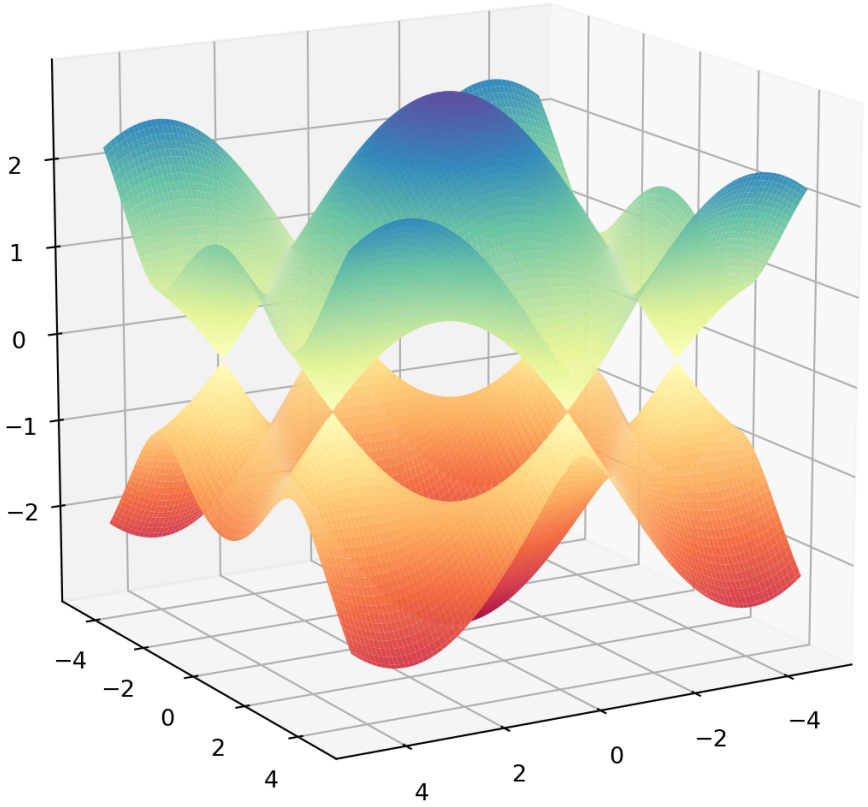


Figure 1: Bandstructre of bulk graphene plotted with kwant

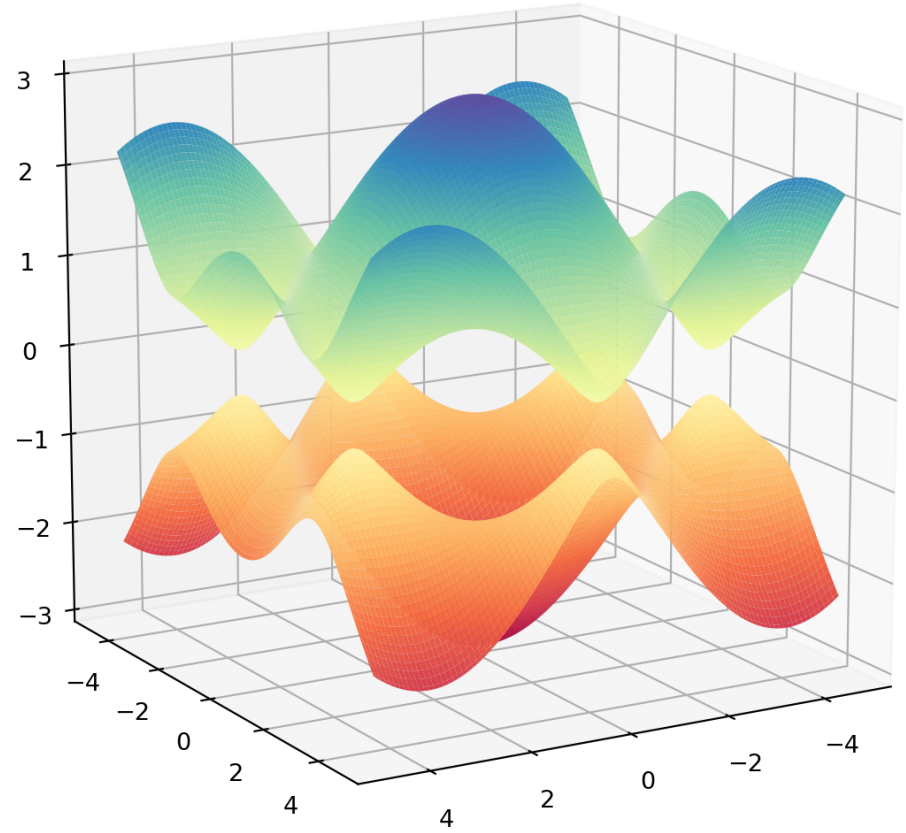


Figure 2: Haldane model ...

5 Topological Anderson Insulator

Say something about topological Anderson insulators.