ELECTROLYTE GATING OF THE TWO-DIMENSIONAL PROXIMATE KITAEV SPIN LIQUID α-RUTHENIUM TRICHLORIDE

A DISSERTATION
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Abstract

The abstract goes here.

"What is true is mine." -Seneca

Acknowledgements

Here is where I thank people and include some quotes.

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Chapter 1

Introduction

Condensed matter physics is the rigorous study of what happens when a large number of cold atoms at high density are allowed to interact. It tells us why and at what temperature water freezes, why magnets attract some materials and not others, why glass is clear, why metal is shiny, and many other things. It is the branch of physics that reveals the richness of our physical world.

1.1 Phases of matter

Many materials that differ in their constituents and microscopic structure have similar bulk properties. For example, although water and mercury at ambient conditions have dramatically different densities and electrical conductivities, they are both nearly incompressible and deform continuously when a shear stress is applied. We capture these similarities by saying water and mercury are both in the liquid phase[1].

A phase of matter has uniform equilibrium thermodynamic properties (density, magentization, etc.) and is defined by these properties being analytic functions of the thermodynamic parameters (e.g., temperature, pressure) [1]. Essentially, for small changes of parameters in a a particular phase, the thermodynamic properties are

[1]Depending on the context, there may be a difference between a *phase* of matter and and *state* of matter. I will use phase in this dissertation as it seems to apply more generally.

smooth functions of the parameters. Phases of matter are separated by phase transitions, where the thermodynamic properties or their derivatives are no longer continuous. For example, when liquid water boils at ambient pressure, its density decreases discontinuously by a factor of 10^6, even though its temperature remains the same.

In many cases, we can also describe phases of matter by their different symmetries, and the phase transitions between them as the breaking or recovery of those symmetries[2]. For example, when a liquid freezes into a solid crystal, the translational symmetry of the liquid phase is broken as the molecules in the liquid assemble themselves into a liquid. Another example is a material transitioning from a non-magnetic to ferromagnetic phase. When the magnetic moments of the material align, it gains an overall macroscopic magnetization, breaking rotational symmetry. The following table lists some common phases and the symmetries they break [2].

Phase	Fluid	Nematic	Smectic-A	Crystal	Heisenberg Magnet	Superfluid
Broken Symmetry	None	Rotational	1D Translation	3D Translation	Rotational	Phase

Table 1.1: Selected phases and their associated broken symmetries

What is condensed matter, what's a spin liquid, why gate it, etc...

[2]Not all phase transitions break symmetries, but this a useful tool in understanding phases

Chapter 2

Properties of α-Ruthenium Trichloride

This is a deep dive, cover Hamiltonian, previous experiments, structure, symmetries, phonons, maybe even solve Kitaev spin liquid

Chapter 3

Electrolyte Gating

This chapter is about electrolyte gating

Bibliography

[1] R. K. Pathria and Paul D. Beale. *Statistical Mechanics*. Butterworth-Heinemann, Oxford, UK, 3rd edition, 2011.

[2] P M Chaikin and T. C. Lubensky. *Principles of Condensed Matter Physics*. Cambridge University Press, Cambrige, UK, 1st edition, 1995.