A Brief introduction to Quantum Computing from the Perspective of Ladder Logic

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Abstract

Insert Better Version of introduction here. Didn't Like the original one.

Keywords: Quantum, QISKit, Computing, Ladder, Logic, QASM, Introduction

1 Introduction 5 lines to max 1/2 page

This section is for context. The how, and why. From here on out, if I refer to a theory that isn't common knowledge, cite the source. [1].

2 Background Concepts

This section is not meant to be an exhaustive list, but, in my personal experience, learning about the background concepts below will greatly assist a person's ability to better understand quantum computing. The following sections will provide a brief explanation of the concepts.

2.1 Balanced Ternary

insert balanced ternary section here along with comparison table.

Use the table and tabular commands for basic tables — see Table 1, for example.

2.2 Reversible Logic Gates

Talk about why reversible logic gates are important to quantum computing, a bit of the history, etc.

Decimal	Binary (IEEE 754*)	Balanced Ternary
0	0	0
3	11	10
5	101	+ 0 -
-254	11000011011111100000000000000000*	- 0 0 - + -

Table 1: comparison table showing equivalent numbers in different display forms

3 Theory 2-3 pages

3.1 Two-dimensional Electron Gas

Here, explain the concept of a 2-DEG in GaAs/AlGaAs. What is a 2-DEG and why does it arise?

3.2 Hall Effect

Explain the classical Hall effect in your own words. What do I measure at $B = 0$? And what happens if $B > 0$? Which effect gives rise to the voltage drop in the vertical direction?

3.3 Quantum Hall Effect

Explain the IQHE in your own words. What does the density of states look like in a 2-DEG when $B = 0$? What are Landau levels and how do they arise? What are edge states? What does the electron transport look like when you change the magnetic field? What do you expect to measure?

4 Experiment 1-2 pages

4.1 Fabrication

Explain a step-by-step recipe for fabrication here. How long did you etch and why? What is an Ohmic contact?

4.2 Experimental set-up

Explain the experimental set-up here. Use a schematic picture (make it yourself in photoshop, paint, ...) to show how the components are connected. Briefly explain how a lock-in amplifier works.

5 Results and interpretation 2-3 pages

Show a graph of the longitudinal resistivity (ρ_{xx}) and Hall resistivity (ρ_{xy}) versus magnetic field, extracted from the raw data shown in figure **??**. You will have the link to the data in your absalon messages, if not e-mail Guen (guen@nbi.dk). Explain how you calculated these values, and refer to the theory.

5.1 Classical regime

Calculate the sheet electron density n_s and electron mobility μ from the data in the low-field regime, and refer to the theory in section 3. Explain how you retrieved the values from the data (did you use a linear fit?). Round values off to 1 or 2 significant digits: 8.1643 = 8.2. Also, 5e-6 is easier to read than 0.000005.

!OBS: This part is optional (only if you have time left). Calculate the uncertainty as follows:

$u(f(x,y,z)) = \sqrt{(\frac{\delta f}{\delta x}u(x))^2 + (\frac{\delta f}{\delta y}u(y))^2 + (\frac{\delta f}{\delta z}u(z))^2}$, where f is the calculated value (n_s or μ), x, y, z are the variables taken from the measurement and $u(x)$ is the uncertainty in x (and so on).

5.2 Quantum regime

Calculate n_s for the high-field regime. Show a graph of the longitudinal conductivity (ρ_{xx}) and Hall conductivity(ρ_{xy}) **in units of the resistance quantum** ($\frac{h}{e^2}$), depicting the integer filling factors for each plateau. Show a graph of the plateau number versus its corresponding value of $1/B$. From this you can determine the slope, which you use to calculate the electron density. Again, calculate the uncertainty for your obtained values.

6 Discussion 1/2-1 page

Discuss your results. Compare the two values of n_s that you've found in the previous section. Compare your results with literature and comment on the difference. If you didn't know the value of the resistance quantum, would you be able to deduce it from your measurements? If yes/no, why?

7 Some LaTeX tips

7.1 How to Include Figures

First you have to upload the image file (JPEG, PNG or PDF) from your computer to writeLaTeX using the upload link the project menu. Then use the includegraphics command to include it in your document. Use the figure environment and the caption command to add a number and a caption to your figure. See the code for Figure **??** in this section for an example.

7.2 How to Write Mathematics

LaTeX is great at typesetting mathematics. Let $X_1, X_2, \ldots, X_n$ be a sequence of independent and identically distributed random variables with $\mathrm{E}[X_i] = \mu$ and $\mathrm{Var}[X_i] = \sigma^2 < \infty$, and let

$$S_n = \frac{X_1 + X_2 + \cdots + X_n}{n} = \frac{1}{n}\sum_{i}^{n} X_i \tag{1}$$

denote their mean. Then as n approaches infinity, the random variables $\sqrt{n}(S_n - \mu)$ converge in distribution to a normal $\mathcal{N}(0, \sigma^2)$.

The equation 1 is very nice.

7.3 How to Make Sections and Subsections

Use section and subsection commands to organize your document. LaTeX handles all the formatting and numbering automatically. Use ref and label commands for cross-references.

7.4 How to Make Lists

You can make lists with automatic numbering ...

1. Like this,
2. and like this.

... or bullet points ...

- Like this,
- and like this.

... or with words and descriptions ...

Word Definition

Concept Explanation

Idea Text

We hope you find writeLaTeX useful, and please let us know if you have any feedback using the help menu above.

References

[1] Richard Newrock, *"What are Joesphson Junctions? How do they work?"* Scientific American

[2] Shor, Peter. *"Quantum Computation"*. MIT OpenCourseware. Massachusetts Institute of Technology, 2003,18.435J / 2.111J / ESD.79J, https://ocw.mit.edu/courses/mathematics/18-435j-quantum-computation-fall-2003/

[3] O'Donnell, Ryan. Wright, John. *"Quantum Computation and Information"*. Carnegie Mellon University, 2015, 15-859BB, https://www.cs.cmu.edu/ odonnell/quantum15/

[4] Jordan, Stephan. *"Quantum Algorithm Zoo"*. National Institute of Standards and Technology (NIST), https://math.nist.gov/quantum/zoo/

[5] QISKit. *"QISKit."* https://github.com/QISKit. Accessed: February 14 2018

[6] Wooten, James. *"Using a Simple Puzzle Game to Benchmark Quantum Computers"*. Medium, January 16 2018. https://medium.com/@decodoku/understanding-quantum-computers-through-a-simple-puzzle-game-a290dde89fb2

[7] Gidney, Craig. *"Algorithmic Assertions"* Google AI, http://algassert.com/. Accessed: May 17, 2018

For extended reading list, consult source code, available at:
https://www.github.com/Macrofarad/ABriefIntroductionToQuantumComputingFromThePerspectiveOfLadderLogic