Computational
Journey of

Quantum Mechanics

Preface

Welcome, fellow explorers of quantum mechanics!

If you're reading this, chances are you're diving into the depths of quantum mechanics and looking for a way to bridge the gap between abstract theory and practical implementation. This course is designed to be that bridge, transforming complex quantum concepts into computational models, algorithms, and visualizations. By the end of this journey, you'll not only understand quantum mechanics theoretically but also be comfortable implementing its principles computationally.

Like it or not, computers play a key role in our understanding of the universe. They help us analyze immense datasets, maintain accuracy in simulations, and provide faster solutions to problems that would take weeks to solve manually. That is why this course exists. Through a structured series of Mathematica notebooks, we will explore quantum mechanics while focusing on code development and algorithmic implementation. Each notebook will combine theoretical explanations with executable code, hands-on exercises, and visualization techniques to reinforce learning.

Here, we will take what you learn in class and apply it computationally—developing numerical techniques, symbolic calculations, and simulations to gain deeper insight into quantum phenomena. Each week, I will provide Mathematica notebooks, and we will have video discussions or local gatherings to clarify concepts, troubleshoot code, and explore advanced topics together.

This course will take you through the fundamentals of scientific computing, computational quantum mechanics, wave mechanics, quantum dynamics, and advanced topics such as quantum chaos, quantum information, and quantum technologies. Whether your goal is research, quantum computing, or a strong computational foundation in physics, this course will equip you with the skills to succeed.

So, let's get started! Bring your curiosity, your questions, and your willingness to experiment—because in quantum mechanics, as in life, the most profound insights often come from unexpected places.

Our Goals and Considerations

This course is meticulously structured to transform your theoretical understanding into practical computational skills. We will bridge the gap between abstract quantum theory and concrete numerical and symbolic implementation, equipping you with the tools to simulate and visualize quantum phenomena across multiple domains.

Learning Approach

Each week, we will explore theoretical concepts and implement them through Mathematica notebooks. Our learning strategy will emphasize:

> Clear, executable code examples.
> Visualization of quantum phenomena.
> Incremental skill development.
> Connections between theory and computation.
> Open-ended exploration opportunities.

Outline

Volume 3: Advanced Quantum Mechanical Systems

Volume 4: Complex Quantum Systems

Volume 5: Frontier Topics in Computational Quantum Mechanics

Volume 6: Quantum Technologies

Weekly Deliverables

Every week, I will provide Mathematica notebooks covering topics of discussion. These notebooks will include:

> *Theoretical Explanations:* Background concepts necessary for understanding the computational approach.
> *Executable Code:* Fully functional code snippets that implement the key ideas.
> *Exploratory Exercises:* Open-ended problems encouraging you to experiment and deepen your understanding.

Additionally, we will have video discussions or local gatherings where you can ask questions, clarify doubts, and discuss implementations. This interactive approach ensures that you not only learn quantum mechanics computationally but also gain hands-on experience in applying these techniques.

FAQ

Q : Do I need prior programming experience?
A : Some familiarity with coding, particularly in Mathematica, is helpful but not required . We will cover essential programming concepts as needed.
Q : How will I receive the notebooks and materials?
A : Weekly Mathematica notebooks will be shared online via ELearn, and on my personal github, and you' ll have access to them for reference and practice .
Q : How can I ask questions or seek help?

A : We will have weekly discussions, and you can also reach out via email or during local gatherings.

About Me

My name is Amir, and I'm a physics student at university of Tehran. I am also a software developer. My experience spans from numerical relativity, to writing front-end and designing user interfaces. I also care about open-source, freedom of knowledge, and decentralization of academia. My life-long project is *Independent Society of Knowledge* and it is embodiment of the things I love to see in scientific community. For contacting me:

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If you have any questions, feel free to reach out. I look forward to embarking on this quantum computational journey with you!