Quantum Mechanics

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Abstract

Quantum Mechanics Lecture Notes.

1 Introduction

1.1 Schrödinger formalism

$$\hat{f}\Phi = E\Phi \tag{1.1}$$

$$\Phi \to dP = |\Phi|^2 dq \tag{1.2}$$

$$x \leftrightarrow \hat{x} \tag{1.3}$$

$$p_x \leftrightarrow -i\hbar \frac{\partial}{\partial x} \tag{1.4}$$

$$f \leftrightarrow \hat{f} \tag{1.5}$$

$$\bar{f} = \text{«} \int \hat{f} dp \quad \text{»} = \int \Phi^* \hat{f} \Phi dq \tag{1.6}$$

1.2 Heisenberg formalism

> Schrödinger was good at math, which is why his quantum mechanics formalism is full of complex mathematical constructs. Heisenberg, on the other hand, had a lot of difficulty with math, which is why his matrix quantum mechanics formalism is limited almost exclusively to linear algebra constructs
>
> Roman ...

Name	Schrödinger	Heisenberg
State Basis	Wave function of basis states $\{\Phi_n\}$	Column vector of basis states $\begin{pmatrix} \phi_1 \\ ... \\ \phi_n \end{pmatrix}$
Observables	Operator $\bar{f} = \int \Phi_n^* \hat{f} \Phi_m$	Operator matrix $\begin{pmatrix} \phi_{11} & ... & \phi_{n1} \\ & ... & \\ \phi_{1n} & ... & \phi_{nn} \end{pmatrix}$
Shrödinger Equation	$\hat{f}\Phi = E\Phi$	$\begin{pmatrix} \phi_{11} & ... & \phi_{n1} \\ & ... & \\ \phi_{1n} & ... & \phi_{nn} \end{pmatrix} \begin{pmatrix} \psi_1 \\ ... \\ \psi_n \end{pmatrix} = \lambda \begin{pmatrix} \psi_1 \\ ... \\ \psi_n \end{pmatrix}$

Building an operator's matrix

1.3 Pauli uncertainty principle

Black holes

Quantum Pencil

??

1.4 Problems

2 Analytical Solutions

2.1 Rectangular quantum well

2.2 Harmonic oscillator

2.3 Spherically symmetric potential

2.4 Problems

3 Quasi-classical approximation

3.1 Problems

4 Spin

4.1 Problems

5 Perturbation theory

5.1 Time-independent

5.2 Time-dependent

5.3 Problems

6 Problem Solutions

6.1 Introduction

6.2 Analytical solutions

6.3 Quasiclassical approximation

6.4 Spin

6.5 Petrubation theory