

QUANTUM MECHANICS

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Abstract

Quantum Mechanics Lecture Notes.

1 Introduction

1.1 Schrödinger formalism

$$\hat{f}\Phi = E\Phi \quad (1.1)$$

$$\Phi \rightarrow dP = |\Phi|^2 dq \quad (1.2)$$

$$x \leftrightarrow \hat{x} \quad (1.3)$$

$$p_x \leftrightarrow -i\hbar \frac{\partial}{\partial x} \quad (1.4)$$

$$f \leftrightarrow \hat{f} \quad (1.5)$$

$$\bar{f} = \int \hat{f} dp = \int \Phi^* \hat{f} \Phi dq \quad (1.6)$$

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 $\begin{pmatrix} \phi_1 \\ \dots \\ \phi_n \end{pmatrix}$
Observables	Operator $\bar{f} = \int \Phi_n^* \hat{f} \Phi_m$	Operator matrix $\begin{pmatrix} \phi_{11} & \dots & \phi_{n1} \\ & \dots & \\ \phi_{1n} & \dots & \phi_{nn} \end{pmatrix}$
Schrödinger Equation	$\hat{f}\Phi = E\Phi$	$\begin{pmatrix} \phi_{11} & \dots & \phi_{n1} \\ & \dots & \\ \phi_{1n} & \dots & \phi_{nn} \end{pmatrix} \begin{pmatrix} \psi_1 \\ \dots \\ \psi_n \end{pmatrix} = \lambda \begin{pmatrix} \psi_1 \\ \dots \\ \psi_n \end{pmatrix}$

Building an operator's matrix

1.3 Pauli uncertainty principle

Black holes

Quantum Pencil

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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 Perturbation theory

References

- [1] D. Easton, “The quantum mechanical tipping pencil – a caution for physics teachers,” European Journal of Physics, vol. 28, no. 6, p. 1097, 2007.