

Introduction to Quantum Mechanics by David J. Griffiths Notes

Chris Doble

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Part I

Theory

1 The Wave Function

1.1 The Schrödinger Equation

- The **Schrödinger equation**

$$i\hbar \frac{\partial \Psi}{\partial t} = -\frac{\hbar^2}{2m} \frac{\partial^2 \Psi}{\partial x^2} + V\Psi$$

is to quantum mechanics what Newton's second law is to classical mechanics. Given suitable initial conditions — typically $\Psi(x, 0)$ — the Schrödinger equation determines $\Psi(x, t)$ for all future time.

1.2 The Statistical Interpretation

- The **Born rule** states that $|\Psi(x, t)|^2$ gives the probability of finding the particle at point x at time t or

$$\int_a^b |\Psi(x, t)|^2 dx$$

gives the probability of finding the particle between a and b at time t .

- This statistical interpretation introduces indeterminacy to quantum mechanics — we can't predict with certainty the particle's position.
- Suppose we measure a particle's position to be C . Where was it before we took the measurement? In the past there were three main schools of thought:
 1. The **realist** position believes that the particle was at C but Ψ doesn't give us enough information to determine that — there's another **hidden variable** that would allow us to.
 2. The **orthodox** position (also known as the **Copenhagen interpretation**) believes that the particle didn't have a definite position but the act of measuring it forced it to do so.
 3. The **agnostic** position believes that it doesn't matter and is potentially unknowable.
- **Bell's theorem** confirms the orthodox interpretation.
- If we take two consecutive measurements of a particle, they will both yield the same result. The first measurement causes the wavefunction to **collapse** such that it is peaked only at the particle's measured location. If the system is allowed to evolve between the measurements the wavefunction will "spread out" but if done in quick succession the result won't change.