Quantum Mechanics Note

量子力学 笔记

Institute for Advanced Study

Victory won't come to us unless we go to it.

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第 1 章

The WAVE FUNCTION

1.1 The Schrödinger Equation

Position

$$x(t)$$

Newton's law

$$m\frac{\mathrm{d}^2x}{\mathrm{d}t^2} = -\frac{\partial^2 x}{\partial x^2}$$

Particle's wave function

$$\Psi(x,t)$$

Schrödinger equation

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

1.2 The Statistical Interpretation

Born's statistical interpretation

$$\int_a^b |\Psi(x,t)|\,\mathrm{d}x = \{\text{ probability of finding the particle between a and b, at time t }\}$$

The statistical interpretation introduces a kind of indeterminacy into quantum mechanics.

There are three plausible answers to this question, and they serve to characterize the main schools of thought regarding to quantum indeterminacy.

- The realist position
- The orthodox position
- The agnostic position

1.3 Probability

1.3.1 Discrete Variables

$$\langle f(j) \rangle = \frac{\Sigma j N(j)}{N} = \sum_{j=0}^{\infty} f(j) P(j)$$

$$\Delta j = j - \langle j \rangle$$

$$\sigma^2 = \langle (\Delta j)^2 \rangle = \langle j^2 \rangle - \langle j \rangle^2$$

1.3.2 Continuous Variables

$\rho(x)\mathrm{d}x = \{$ probability that an individual (chosen at random) lies between x and $x + \mathrm{d}x$ $\}$

$$\langle f(x) \rangle = \int_{-\infty}^{+\infty} f(x)\rho(x)\mathrm{d}x$$

$$\sigma^2 = \langle (\Delta x)^2 \rangle = \langle x^2 \rangle - \langle x \rangle^2$$

1.4 Normalization

$$\int_{-\infty}^{+\infty} |\Psi(x,t)|^2 \, \mathrm{d}x = 1$$