Review of Quantum Mechanics

This is a review of important concepts in quantum mechanics, aimed at the reader who has already taken a first course on quantum mechanics.

Quantum States

States are represented by vectors in a Hilbert space. A wavefunction ψ is a solution to the Schrödinger equation. It also represents the components of a *state vector* Ψ. If the wavefunction depends on the position $\mathbf{r}$, that is, $\psi = \psi(\mathbf{r})$, then it is a solution to the Schrödinger equation in *position space* components of Ψ in an infinite dimension along the direction corresponding to a definite value $\mathbf{r}$ of the position. The wavefunction is also a type of *projection*. The state vector Ψ is given by

$$|\Psi\rangle = \int d^3\mathbf{r}|\mathbf{r}\rangle\langle\mathbf{r}|\Psi\rangle \tag{1}$$

and this component in terms of Dirac notation is given by

$$\langle\mathbf{r}|\Psi\rangle = \psi(\mathbf{r}).$$

Positions are part of a continuous set, so at first: $\mathbf{r} \in [-\infty, \infty]$. Since each component in the state vector space is associated to a value of the position vector, we have infinite directions in this space and each direction is labeled by $\mathbf{r}$.

The state vector in the form (1) is just one of the possible representations. In particular, we used the position representation. We can use another system variable such as the momentum. In this case, we have

$$\langle\mathbf{p}|\Psi\rangle = \phi(\mathbf{p}),$$

Stationary States

Suggested Reading

- Weinberg, S., 2015. *Lectures on quantum mechanics.* Cambridge University Press.
- Merzbacher, E. (1998) *Quantum Mechanics.* John Wiley & Sons.