量子力学基本原理回顾

1. Hamiltonian H,

2. Hilbert space:　态矢量 $|\alpha\rangle$，对偶空间：左矢$\langle\alpha|$

维度：$|\alpha\rangle = \sum_i c_i |i\rangle$，　独立右矢$|i\rangle$的个数

3. 力学量是厄密算符：　$Q = Q^\dagger$

$$Q|\alpha\rangle \leftrightarrow \langle\alpha|Q^\dagger$$

- 本征方程：　$Q|q_i\rangle = q_i|q_i\rangle$

    - 本征值是实的

    - 属于不同本征值的本征矢正交

4. 测量： 假设一个态矢$|\alpha\rangle = \sum_i c_i |q_i\rangle$

- 测Q得到q_i，其几率为 $|c_i|^2$，

- 期望值： $$\langle Q \rangle = \sum_i |c_i|^2 q_i = \langle \alpha | Q | \alpha \rangle$$

5. 动力学：

经典力学 $\dot{\mathbf{p}} = -\frac{\partial H}{\partial \mathbf{q}}, \quad \dot{\mathbf{q}} = \frac{\partial H}{\partial \mathbf{p}}$

Q(q,p) 满足$\frac{d}{dt}Q(p,q) = \{Q, H\}$, 其中$\{Q, H\} = \frac{\partial Q}{\partial q}\frac{\partial H}{\partial p} - \frac{\partial Q}{\partial p}\frac{\partial H}{\partial q}$

- H picture， 海森堡方程， $\frac{dQ}{dt} = \frac{1}{i\hbar}[Q, H]$; $\frac{\partial |\alpha\rangle}{\partial t} = 0$

- S picture, $i\hbar\frac{\partial |\alpha\rangle}{\partial t} = H|\alpha\rangle$; $\frac{dQ}{dt} = 0$

- $\frac{d}{dt}\langle \alpha | Q | \alpha \rangle = \frac{1}{i\hbar}\langle \alpha | [Q, H] | \alpha \rangle$

6. Q表象：　基矢 $|q_i\rangle$

$$|\alpha\rangle = (c_1^*, c_2^*, \cdots, c_n^*)^\dagger$$

算符 $A \to A_{ij} = \langle q_i | A | q_j \rangle$

- 坐标表象　$i\hbar\dfrac{\partial}{\partial t}\langle x|\alpha\rangle = H(x, -i\hbar\dfrac{\partial}{\partial x})\langle x|\alpha\rangle$