Chapter 1

The New Quantum Universe

物理学家, 就像一个好侦探一样, 仔细分析各种证据, 遵循福尔摩斯说过的一句格言:”当你把不可能的事情都排出了以后, 剩下的选择,不管看起来多么不太可能, 一顶是对的.”
光子的本质是量子力学的

Chapter 2

Quantique

2.1 Equation de Schrȯndinger

推广到三维情况下，方程为:

$$\psi(\mathbf{r}, t) = A\cos(\mathbf{k}\cdot\mathbf{r} - \omega t + \varphi)$$

其中：r是三维空间中的位置矢量；· 是矢量点积；k是波矢。这一方程描述了平面波。一维情况下，波矢的大小是角波数

$$|\mathbf{k}| = 2\pi/\lambda$$

波矢的方向是平面波行进的方向.

波动方程是双曲形偏微分方程的最典型代表,其最简形式可表示为:关于位置x 和时间t 的标量函数u(代表各点偏离平衡位置的距离)满足:

$$\frac{\partial^2 u}{\partial t^2} = c^2\nabla^2 u$$

这里c通常是一个固定常数，代表波的传播速率. 在针对实际问题的波动方程中，一般都将波速表示成可随波的频率变化的量，这种处理对应真实物理世界中的色散现象。此时，c 应该用波的相速度代替:$v_{\mathrm{p}} = \frac{\omega}{k}$

上面的波动方程可以化成下面的形式

$$\left(\nabla^2 - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}\right)u(\mathbf{r}, t) = 0.$$

Separation of variables begins by assuming that the wave function $u(r,t)$ is in fact separable:

$$u(\mathbf{r}, t) = A(\mathbf{r})T(t)$$

Substituting this form into the wave equation, and then simplifying, we obtain the following equation:

$$\frac{\nabla^2 A}{A} = \frac{1}{c^2 T}\frac{d^2 T}{dt^2}.$$

Notice the expression on the left-hand side depends only on r , whereas the right-hand expression depends only on t . As a result, this equation is valid in the general case if and only if both sides of the equation are equal to a constant value. From this observation, we obtain two equations, one for $A(r)$, the other for $T(t)$:

$$\frac{\nabla^2 A}{A} = -k^2$$

and

$$\frac{1}{c^2 T}\frac{d^2 T}{dt^2} = -k^2$$

Rearranging the first equation, we obtain the Helmholtz equation:

$$\nabla^2 A + k^2 A = (\nabla^2 + k^2)A = 0$$

Likewise, after making the substitution

$$\omega \stackrel{\text{def}}{=} kc$$

the second equation becomes

$$\frac{d^2 T}{dt^2} + \omega^2 T = \left(\frac{d^2}{dt^2} + \omega^2\right) T = 0,$$

where k is the wave vector and ω is the angular frequency.