

$$\Psi(\vec{r}, t)$$

$$\rho(\vec{r}, t) = \Psi(\vec{r}, t) \Psi^*(\vec{r}, t).$$

$$(1) \int_V d\vec{r} \rho(\vec{r}, t) = 1.$$

$$(2) \Psi(\vec{r}, t) = C e^{i(\vec{k} \cdot \vec{r} - \frac{E(k)t}{\hbar})},$$

$$(3) \frac{C}{\hbar k}$$

$$E(k) = \frac{\hbar^2 k^2}{2m}$$

$$(4) \frac{V}{L_x \bar{L}_y L_z}$$

$$\frac{L_x}{L_y}$$

$$\frac{L_z}{L_x}$$

$$\Psi(x, y, z) = \Psi(x + L_x, y, z), \Psi(x, y, z) = \Psi(x, y + L_y, z), \Psi(x, y, z) = \Psi(x, y, z + L_z).$$

$$(5) \frac{V}{L_x \bar{L}_y L_z}$$

$$\int_0^{L_x} \int_0^{L_y} \int_0^{L_z} dx dy dz C C^* = 1,$$

$$(6) C = \sqrt{\frac{1}{L_x L_y L_z}} = \sqrt{\frac{1}{V}}.$$

$$(7) k_x = \frac{2\pi}{L_x} n_x, n_x = 0, \pm 1 \pm 2, \dots, k_y = \frac{2\pi}{L_y} n_y, n_y = 0, \pm 1 \pm 2, \dots, k_z = \frac{2\pi}{L_z} n_z, n_z = 0, \pm 1 \pm 2, \dots$$

$$(8) \frac{k_x, k_y, k_z}{\vec{k}}$$

$$\frac{k_x}{k}$$

$$\Delta = \frac{8\pi^3}{L_x L_y L_z}.$$

$$(9) \frac{\vec{k}}{k}$$

$$1/\Delta = \frac{L_x L_y L_z}{8\pi^3}.$$

$$(10) \frac{V}{L_x \bar{L}_y L_z}$$

$$\frac{N}{\hbar/2}$$

$$\tilde{s}_z = \pm \hbar/2$$

$$k_x, k_y, k_z, s_z$$

$$k_x, k_y, k_z, s_z$$

$$f(\vec{k}, s_z)$$

$$N = 2 \sum_{\vec{k}} f(\vec{k}),$$

$$(11) \frac{k_x, k_y, k_z}{s_z}$$

$$\frac{2}{k_x, k_y, k_z}$$

$$N = 2 \frac{L_x L_y L_z}{8\pi^3} \int d\vec{k} f(\vec{k}),$$

$$(12) \frac{\vec{k}}{k}$$

$$\frac{d\vec{k}}{L_x L_y L_z}$$

$$\frac{1}{8\pi^3}$$

$$dk$$

$$n_e \equiv \frac{N}{L_x L_y L_z} = 2 \frac{1}{8\pi^3} \int_0^{2\pi} d\phi \int_0^\pi d\theta \sin \theta \int_0^\infty dk k^2 f(k),$$

$$(13) \frac{n_e}{\phi}$$

$$\frac{\phi}{\theta}$$

$$n_e = \frac{1}{\pi^2} \int_0^\infty dk k^2 f(k).$$