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

$$\rho(\vec{r},t) = \Psi(\vec{r},t)\Psi^*(\vec{r},t). \tag{1}$$

$V$

$$\int_V d\vec{r}\rho(\vec{r},t) = 1. \tag{2}$$

$$\Psi(\vec{r},t) = Ce^{i(\vec{k}\cdot\vec{r}-\frac{E(k)t}{\hbar})}, \tag{3}$$

$C$

$\hbar\vec{k}$

$$E(k) = \frac{\hbar^2 k^2}{2m} \tag{4}$$

$V \equiv$

$L_x L_y L_z$

$L_x$

$L_y$

$L_z$

$$\Psi(x,y,z) = \Psi(x+L_x,y,z), \Psi(x,y,z) = \Psi(x,y+L_y,z), \Psi(x,y,z) = \Psi(x,y,z+L_z). \tag{5}$$

$V \equiv$

$L_x L_y L_z$

$$\int_0^{L_x}\int_0^{L_y}\int_0^{L_z} dxdydzCC^* = 1, \tag{6}$$

$$C = \sqrt{\frac{1}{L_x L_y L_z}} = \sqrt{\frac{1}{V}}. \tag{7}$$

$$k_x = \frac{2\pi}{L_x}n_x, n_x = 0, \pm1\pm2, ..., k_y = \frac{2\pi}{L_y}n_y, n_y = 0, \pm1\pm2, ..., k_z = \frac{2\pi}{L_z}n_z, n_z = 0, \pm1\pm2, .... \tag{8}$$

$k_x, k_y, k_z$

$\vec{k}$

$\vec{k}$

$\vec{k}$

$$\Delta = \frac{8\pi^3}{L_x L_y L_z}. \tag{9}$$

$\vec{k}$

$\vec{k}$

$$1/\Delta = \frac{L_x L_y L_z}{8\pi^3}. \tag{10}$$

$V \equiv$

$L_x L_y L_z$

$N$

$\hbar/2$

$z$

$s_z =$

$\pm\hbar/2$

$k_x, k_y, k_z, s_z$

$k_x, k_y, k_z, s_z$

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

$$N = 2\sum_{\vec{k}} f(\vec{k}), \tag{11}$$

$k_x, k_y, k_z$

$s_z$

$2$

$k_x, k_y, k_z$

$$N = 2\frac{L_x L_y L_z}{8\pi^3}\int d\vec{k} f(\vec{k}), \tag{12}$$

$\vec{k}$

$d\vec{k}$

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

$d\vec{k}$

$$n_e \equiv \frac{N}{L_x L_y L_z} = 2\frac{1}{8\pi^3}\int_0^{2\pi} d\phi \int_0^{\pi} d\theta \sin\theta \int_0^{\infty} dk k^2 f(k), \tag{13}$$

$n_e$

$\phi$

$\theta$

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