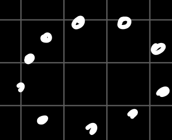
① 3rd May
② preview of 3rd may



$b_k^+ = a_{k\uparrow}^+ a_{-k\downarrow}^+$ $\quad b_k^{+2} = 0 \quad b_{-k}^2 = 0$

$b_k^+ b_{-k}^+ = 0$

$[b_k, b_k^+] =$

$\eta_k^+ = b_k^+ - b_{-k}^+$

not working at $-k$

$[b_k, b_k^+]$

$= [a_{k\uparrow}^+ a_{-k\downarrow}^+ , a_{k\uparrow} a_{-k\downarrow}]$

$a_{-k\downarrow}^+ a_{-k\downarrow} + a_{k\uparrow} a_{k\uparrow}^+ \; a_{-k\downarrow} a_{-k\downarrow}^+$

$+ (1 - n_{k\uparrow})(1 - n_{-k\downarrow})$

$= -a_{k\uparrow}^+ a_{k\uparrow} \quad n_{-k\downarrow} \quad = [b_k, b_k^+]$

$= - n_{k\uparrow} - n_{-k\downarrow}$

$= 1 - n_{k\uparrow} - n_{-k\downarrow}$

$= a_{k\uparrow}^+ a_{-k\downarrow}^+ a_{-k\downarrow} a_{k\uparrow}$

$b_k^+ b_k = \hat{n}_{k\uparrow} \hat{n}_{-k\downarrow}$

$=$

$$\psi_N = \mathcal{N}\left(\sum_k c_k b_k^+\right)^N |0\rangle \qquad \sum_k \frac{|c_k|^2}{1+|c_k|^2} = N$$

$$= \mathcal{N}\ \hat{\Omega}^N |0\rangle$$

$$\exp \hat{\Omega}|0\rangle = \prod_k (1 + c_k b_k^+)|0\rangle = \sum a_n \psi_n$$

$$a_n = \int_0^{2\pi} e^{-in\phi} \prod_k (1 + e^{i\phi} c_k b_k^+) \frac{d\phi}{2\pi}$$

$$\Rightarrow a_n|\psi_n\rangle = \int_0^{2\pi} \frac{d\phi}{2\pi} e^{-in\phi} \prod_k (1 + e^{i\phi} c_k b_k^+)|0\rangle$$

$$\underbrace{\psi_n}_{\#\text{ of cooper pairs}} = \left(\sum_k c_k b_k^+\right)^n |0\rangle \qquad a_n \simeq N$$

$$a_n = \int_0^{2\pi} \frac{d\phi}{2\pi} e^{-in\phi} \langle \psi_n | \exp\left[\sum e^{i\phi} c_k b_k^+\right] |0\rangle$$

$$\Rightarrow a_n = \int_0^{2\pi} \frac{d\phi}{2\pi} e^{-in\phi} \langle 0| \Omega^{+n} \exp[e^{i\phi}\hat{\Omega}]|0\rangle$$

$$|\psi_{BCS}\rangle = N_{BCS} \sum_n \frac{\Omega^n}{n!}|0\rangle \qquad N_{BCS}^2 \times \prod (1+|c_k|^2) = 1$$

$$a_n = \frac{N_{BCS}}{n!} \qquad N_{BCS} = \frac{1}{\left[\prod_k (1+|c_k|^2)\right]^{1/2}}$$

$$\sum_k \frac{|c_k|^2}{1+|c_k|^2} = \underline{\underline{N}}$$

$$N_{BCS} = \frac{1}{\prod_k \sqrt{1+|c_k|^2}} \qquad a_n = \frac{1}{n!} \prod_k \frac{1}{\sqrt{1+|c_k|^2}}$$

$$a_n = \frac{1}{n!} \prod_k \frac{1}{\sqrt{1+|c_k|^2}}$$

$$a_n = \frac{N_{BCS}}{n!\, N_n}$$

$$a_n \psi_n$$

$$\frac{N_{BCS}}{N} \, N \, \frac{\Omega^n |0\rangle}{n!}$$

$$\psi_N = N_n \left(\sum_k c_k b_k^\dagger\right)^N |0\rangle$$

$$\hat{\Omega}^N |vac\rangle$$

$$\hat{\Omega}^\dagger = \sum c_k^* b_k$$

$$\hat{\Omega}^\dagger \hat{\Omega} =$$

$$b^\dagger$$

$$e \cdot b^\dagger_{2n}$$