

Considerando soltanto i termini ovviamente non diversi da zero si ha:

$$\begin{aligned}
 a_{\nu}^{\dagger} a_{\mu}^{\dagger} a_{\mu} a_{\nu} &= N [a_{\nu}^{\dagger} a_{\mu}^{\dagger} a_{\mu} a_{\nu}] \\
 &+ N [a_{\mu}^{\dagger} a_{\mu}] a_{\nu}^{\dagger} a_{\nu} + N [a_{\nu}^{\dagger} a_{\nu}] a_{\mu}^{\dagger} a_{\mu} \\
 &- N [a_{\mu}^{\dagger} a_{\nu}] a_{\nu}^{\dagger} a_{\mu} - N [a_{\nu}^{\dagger} a_{\mu}] a_{\mu}^{\dagger} a_{\nu} \\
 &+ \overline{a_{\mu}^{\dagger} a_{\mu}} \overline{a_{\nu}^{\dagger} a_{\nu}} - \overline{a_{\nu}^{\dagger} a_{\mu}} \overline{a_{\mu}^{\dagger} a_{\nu}}
 \end{aligned}$$

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• Riscriviamo l'hamiltoniana (2) usando la (6) e le (4) ($i, j \leq k_F$)

$$\begin{aligned}
 \hat{H} &= \sum_{\nu \nu'} T_{\nu \nu'} a_{\nu}^{\dagger} a_{\nu'} + \frac{1}{4} \sum_{\mu \mu' \nu \nu'} \overline{V}_{\mu \nu \nu' \mu'} N [a_{\mu}^{\dagger} a_{\nu}^{\dagger} a_{\nu'} a_{\mu'}] \\
 &+ N [a_{\mu}^{\dagger} a_{\mu}] \delta_{\nu \nu'} \delta_{\nu' \nu} + N [a_{\nu}^{\dagger} a_{\nu}] \delta_{\mu \mu'} \delta_{\mu' \mu} - N [a_{\mu}^{\dagger} a_{\nu'}] \delta_{\nu \nu'} \delta_{\nu' \nu} - N [a_{\nu}^{\dagger} a_{\mu'}] \delta_{\mu \mu'} \delta_{\mu' \mu} \\
 &+ \delta_{\mu \mu'} \delta_{\nu \nu'} \delta_{\nu \nu'} \delta_{\nu' \nu} - \delta_{\nu \nu'} \delta_{\nu' \nu} \delta_{\mu \mu'} \delta_{\mu' \mu} \} = \\
 &= \sum_{\nu \nu'} T_{\nu \nu'} a_{\nu}^{\dagger} a_{\nu'} + \frac{1}{4} \sum_{\mu \mu' \nu \nu'} \overline{V}_{\mu \nu \nu' \mu'} N [a_{\mu}^{\dagger} a_{\nu}^{\dagger} a_{\nu'} a_{\mu'}] \\
 &+ \frac{1}{4} \sum_{\mu \mu'} \overline{V}_{\mu \mu' \mu' \mu} N [a_{\mu}^{\dagger} a_{\mu}] + \frac{1}{4} \sum_{\nu \nu'} \overline{V}_{\nu \nu' \nu' \nu} N [a_{\nu}^{\dagger} a_{\nu}] \\
 &- \frac{1}{4} \sum_{\mu \nu \nu'} \overline{V}_{\mu \nu \nu' \mu} N [a_{\mu}^{\dagger} a_{\nu'}] - \frac{1}{4} \sum_{\nu \mu \mu'} \overline{V}_{\nu \mu \mu' \nu} N [a_{\nu}^{\dagger} a_{\mu'}] \\
 &+ \frac{1}{4} \sum_{ij} \overline{V}_{ijij} - \frac{1}{4} \sum_{ij} \overline{V}_{ijji} =
 \end{aligned}$$

(7)

• Data la definizione 13 di $\overline{V}_{\nu \mu \nu' \mu'}$ si ha:

$$\overline{V}_{\nu \mu \nu' \mu'} = -\overline{V}_{\mu \nu \nu' \mu'} = +\overline{V}_{\mu \nu \mu' \nu'} = -\overline{V}_{\nu \mu \mu' \nu'}$$

(8)