

La parte destra dell'equazione:

$$\langle \bar{\Phi}_0 | [a_i^\dagger a_m, Q_p^\dagger] | \bar{\Phi}_0 \rangle = \sum_{ph} X_{ph} \left\{ \langle \bar{\Phi}_0 | a_i^\dagger a_m \overset{\downarrow \delta_{mp} \delta_{ph}}{a_p^\dagger a_h} | \bar{\Phi}_0 \rangle - \langle \bar{\Phi}_0 | a_p^\dagger a_h \overset{\downarrow \delta_{pi} \delta_{mh}}{a_i^\dagger a_m} | \bar{\Phi}_0 \rangle \right\} \quad (4)$$

E la parte sinistra

$$\begin{aligned} \langle \bar{\Phi}_0 | [a_i^\dagger a_m, [H, Q_p^\dagger]] | \bar{\Phi}_0 \rangle &= \langle \bar{\Phi}_0 | [a_i^\dagger a_m [H, Q_p^\dagger] - [H, Q_p^\dagger] a_i^\dagger a_m] | \bar{\Phi}_0 \rangle = \\ &= \langle \bar{\Phi}_0 | a_i^\dagger a_m (H Q_p^\dagger - Q_p^\dagger H) | \bar{\Phi}_0 \rangle - \langle \bar{\Phi}_0 | [H, Q_p^\dagger] a_i^\dagger a_m | \bar{\Phi}_0 \rangle = \\ &= \sum_{ph} X_{ph} \left\{ \langle \bar{\Phi}_0 | a_i^\dagger a_m H a_p^\dagger a_h | \bar{\Phi}_0 \rangle - \langle \bar{\Phi}_0 | a_i^\dagger a_m a_p^\dagger a_h H | \bar{\Phi}_0 \rangle \right\} \\ &= \sum_{ph} X_{ph} \left\{ \langle \bar{\Phi}_0 | a_i^\dagger a_m \left(\sum_{\nu} h_{\nu} a_{\nu}^\dagger a_{\nu} + \frac{1}{4} \sum_{\mu \nu \mu' \nu'} \bar{V}_{\mu \nu \mu' \nu'} [a_{\mu}^\dagger a_{\nu}^\dagger a_{\nu'} a_{\mu'}] \right) a_p^\dagger a_h | \bar{\Phi}_0 \rangle \right. \\ &\quad \left. - \langle \bar{\Phi}_0 | a_i^\dagger a_m a_p^\dagger a_h \left(\sum_{\nu} h_{\nu} a_{\nu}^\dagger a_{\nu} + \frac{1}{4} \sum_{\mu \nu \mu' \nu'} \bar{V}_{\mu \nu \mu' \nu'} [a_{\mu}^\dagger a_{\nu}^\dagger a_{\nu'} a_{\mu'}] \right) | \bar{\Phi}_0 \rangle \right\} \end{aligned}$$

Consideriamo la parte con h_{ν}

$$E_{\nu} \langle \bar{\Phi}_0 | a_i^\dagger a_m a_{\nu}^\dagger a_{\nu} a_p^\dagger a_h | \bar{\Phi}_0 \rangle = \delta_{\nu p} \delta_{\nu m} \delta_{mp} \delta_{ih} E_m \quad \text{oppure} \quad -\delta_{\nu i} \delta_{\nu m} \delta_{mh} E_i$$

$$E_{\nu} \langle \bar{\Phi}_0 | a_i^\dagger a_m a_p^\dagger a_h a_{\nu}^\dagger a_{\nu} | \bar{\Phi}_0 \rangle = \delta_{\nu i} \delta_{\nu h} \delta_{mp} E_i$$

Quindi la parte sinistra diventa:

$$= X_{im} (E_m - E_i) + \sum_{j \neq i} E_j - \sum_{j \neq i} E_j + \sum_{ph} X_{ph} \bar{V}_{phmi}$$