

# BOSONY

## Opakování:

$$[a_k, a_e] = [a_k^+, a_e^+] = 0$$

$$[a_k, a_e^+] = \delta_{ke}, \quad [a_k^+, a_e] = -\delta_{ek}$$

Najděte komutační relace:

$$\begin{aligned} \bullet [a_k^+ a_e, a_n] &= a_k^+ [a_e, a_n] + [a_k^+, a_n] a_e \\ &= 0 - \delta_{nk} a_e \end{aligned}$$

$$\begin{aligned} \bullet [a_k^+ a_e, a_n^+] &= a_k^+ [a_e, a_n^+] + [a_k^+, a_n^+] a_e \\ &= a_k^+ \delta_{en} + 0 \end{aligned}$$

# FERMIONY

## Opakování:

$$\{a_k, a_e\} = \{a_k^+, a_e^+\} = 0$$

$$\{a_k, a_e^+\} = \delta_{ke} = \{a_e^+, a_k\}$$

Najděte kombinační relace:

→ neznám, odvodím

$$[AB, C] = ABC - CAB = A \overbrace{(BC + CB)}^{\substack{\{B,C\} \\ +ACB - ACB}} - \overbrace{(AC + CA)}^{\{A,C\}} B$$

$$\begin{aligned} \bullet [a_k^\dagger a_e, a_n] &= a_k^\dagger \{a_e, a_n\} - \{a_k^\dagger, a_n\} a_e \\ &= 0 - \delta_{nk} a_e \end{aligned}$$

$$\begin{aligned} \bullet [a_k^\dagger a_e, a_n^\dagger] &= a_k^\dagger \{a_e, a_n^\dagger\} - \{a_k^\dagger, a_n^\dagger\} a_e \\ &= \delta_{en} a_k^\dagger - 0 \end{aligned}$$