

goldstone

$$a_p \equiv \begin{array}{c} p \\ \circ \\ \uparrow \end{array} \quad a_p^\dagger \equiv \begin{array}{c} \uparrow \\ \circ \\ p \end{array} \quad b_a \equiv \begin{array}{c} a \\ \bullet \\ \uparrow \end{array} \quad b_i \equiv \begin{array}{c} i \\ \bullet \\ \downarrow \end{array} \quad b_a^\dagger \equiv \begin{array}{c} \uparrow \\ \bullet \\ a \end{array} \quad b_i^\dagger \equiv \begin{array}{c} \downarrow \\ \bullet \\ i \end{array} \quad (1)$$

$$a_{q_1 q_2 \cdots q_n}^{p_1 p_2 \cdots p_n} \equiv \begin{array}{c} p_1 \quad p_2 \quad \cdots \quad p_n \\ \uparrow \quad \uparrow \quad \cdots \quad \uparrow \\ \circ \text{---} \circ \cdots \circ \\ \uparrow \quad \uparrow \quad \cdots \quad \uparrow \\ q_1 \quad q_2 \quad \cdots \quad q_n \end{array} \quad \tilde{a}_{q_1 q_2 \cdots q_n}^{p_1 p_2 \cdots p_n} \equiv \begin{array}{c} p_1 \quad p_2 \quad \cdots \quad p_n \\ \uparrow \quad \uparrow \quad \cdots \quad \uparrow \\ \bigcirc \text{---} \bigcirc \cdots \bigcirc \\ \uparrow \quad \uparrow \quad \cdots \quad \uparrow \\ q_1 \quad q_2 \quad \cdots \quad q_n \end{array} \quad (2)$$

$$\left(\frac{1}{n!}\right)^2 v_{p_1 p_2 \dots p_n}^{q_1 q_2 \dots q_n} \tilde{a}_{q_1 q_2 \dots q_n}^{p_1 p_2 \dots p_n} \equiv \text{Diagram} \quad (3)$$

$$h_p^q a_q^p \equiv \text{diagram} \quad (4)$$

$$\text{Diagram 1} = \text{Diagram 2} + \text{Diagram 3} \quad (5)$$

$$\begin{array}{c} \square \text{---} \circ \\ \updownarrow \end{array} = \begin{array}{c} \square \text{---} \bullet \\ \updownarrow \end{array} + \begin{array}{c} \diagup \diagdown \\ \square \text{---} \bullet \\ \updownarrow \end{array} + \begin{array}{c} \diagup \diagdown \\ \square \text{---} \bullet \\ \diagup \diagdown \end{array} + \begin{array}{c} \square \text{---} \bullet \\ \updownarrow \end{array} \quad (6)$$

$$\frac{1}{4}\overline{g}_{pq}^{rs}a_{rs}^{pq} = \text{diagram of a wavy line between two vertices} \quad (7)$$

$$\begin{array}{c} \uparrow \\ \text{---} \bigcirc \end{array} \begin{array}{c} \uparrow \\ \text{---} \bigcirc \end{array} \begin{array}{c} \uparrow \\ \text{---} \bigcirc \end{array} = \begin{array}{c} \uparrow \\ \text{---} \bigcirc \end{array} \begin{array}{c} \uparrow \\ \text{---} \bigcirc \end{array} \begin{array}{c} \uparrow \\ \text{---} \bigcirc \end{array} + \begin{array}{c} \uparrow \\ \text{---} \bigcirc \end{array} \begin{array}{c} \uparrow \\ \text{---} \bigcirc \end{array} \begin{array}{c} \uparrow \\ \text{---} \bigcirc \end{array} + \begin{array}{c} \uparrow \\ \text{---} \bigcirc \end{array} \begin{array}{c} \uparrow \\ \text{---} \bigcirc \end{array} \begin{array}{c} \uparrow \\ \text{---} \bigcirc \end{array} + \begin{array}{c} \uparrow \\ \text{---} \bigcirc \end{array} \begin{array}{c} \uparrow \\ \text{---} \bigcirc \end{array} \begin{array}{c} \uparrow \\ \text{---} \bigcirc \end{array} \quad (8)$$

$$\text{Diagram 1} = \text{Diagram 2} + \text{Diagram 3} + \text{Diagram 4} + \text{Diagram 5} + \text{Diagram 6} + \text{Diagram 7} + \text{Diagram 8} + \text{Diagram 9} + \text{Diagram 10} + \text{Diagram 11} \quad (9)$$

$$\begin{array}{c} \square \\ \downarrow \\ \circ \end{array} + \begin{array}{c} \downarrow \\ \circ - \text{wavy} - \circ \\ \downarrow \end{array} = E_0 + \begin{array}{c} \otimes \\ \downarrow \\ \circ \end{array} + \begin{array}{c} \downarrow \\ \circ - \text{wavy} - \circ \\ \downarrow \end{array}, \quad E_0 \equiv \begin{array}{c} \square \\ \downarrow \\ \circ \end{array} \rightarrow \begin{array}{c} \circ \end{array} + \begin{array}{c} \leftarrow \circ \end{array} \text{--- wavy ---} \begin{array}{c} \circ \rightarrow \end{array}, \quad \begin{array}{c} \otimes \\ \downarrow \\ \circ \end{array} \equiv \begin{array}{c} \square \\ \downarrow \\ \circ \end{array} + \begin{array}{c} \leftarrow \circ \end{array} \text{--- wavy ---} \begin{array}{c} \circ \rightarrow \end{array} \quad (10)$$

$$\begin{array}{c}
\text{---} \\
\text{---} \\
1 + \text{---} \\
\text{---} \\
\text{---}
\end{array}
+ \text{---}
= \text{---} + \text{---} + \text{---} + \text{---} + \text{---}
\quad (11)$$

$$\begin{array}{c} \text{---} \text{---} \text{---} \\ \text{---} \text{---} \text{---} \end{array} \left(\begin{array}{c} \text{---} \uparrow \downarrow \text{---} \otimes \text{---} \uparrow \downarrow \text{---} \\ + \\ \text{---} \uparrow \downarrow \text{---} \text{---} \text{---} \uparrow \downarrow \text{---} \end{array} \right) = \begin{array}{c} \text{---} \text{---} \text{---} \\ \text{---} \text{---} \text{---} \end{array} \left(\begin{array}{c} \text{---} \uparrow \downarrow \text{---} \\ \text{---} \uparrow \downarrow \text{---} \end{array} \right) \exp \left(\begin{array}{c} \text{---} \uparrow \downarrow \text{---} \\ \text{---} \uparrow \downarrow \text{---} \end{array} \right) \quad (12)$$

$$\begin{aligned}
& \overline{\overline{a \quad i \quad b \quad j}} \\
& \begin{array}{c} \text{---} \otimes \text{---} \text{---} + \text{---} \text{---} \text{---} \text{---} \\ \text{---} \end{array} = \\
& \exp \left(\text{---} \text{---} \right) \\
& \overline{\overline{a \quad i \quad b \quad j}} \\
& \begin{array}{c} a \quad i \quad b \quad j \\ \text{---} \end{array} + \begin{array}{c} a \quad i \quad b \quad j \\ \text{---} \otimes \text{---} \end{array} + \begin{array}{c} i \quad a \quad j \quad b \\ \text{---} \otimes \text{---} \end{array} + \begin{array}{c} a \quad i \quad b \quad j \\ \text{---} \text{---} \end{array} + \begin{array}{c} i \quad a \quad j \quad b \\ \text{---} \text{---} \end{array} \\
& + \begin{array}{c} a \quad i \quad b \quad j \\ \text{---} \end{array} + \begin{array}{c} a \quad b \quad i \quad j \\ \text{---} \end{array} + \begin{array}{c} a \quad i \quad b \quad j \\ \text{---} \end{array} + \begin{array}{c} a \quad i \quad b \quad j \\ \text{---} \end{array} + \begin{array}{c} i \quad a \quad j \quad b \\ \text{---} \end{array} \\
& + \begin{array}{c} a \quad i \quad b \quad j \\ \text{---} \end{array} + \begin{array}{c} i \quad a \quad j \quad b \\ \text{---} \end{array} + \begin{array}{c} a \quad i \quad b \quad j \\ \text{---} \end{array} + \begin{array}{c} i \quad a \quad j \quad b \\ \text{---} \end{array}
\end{aligned} \tag{13}$$

$$\begin{aligned}
& \overline{\overline{a \quad i}} \\
& \begin{array}{c} 1 + \text{---} \\ \text{---} \otimes \text{---} + \text{---} \text{---} \\ 1 + \text{---} \end{array} \\
& \overline{\overline{a \quad i}}
\end{aligned} \tag{14}$$

$$\begin{aligned}
& \overline{\overline{1 + \text{---}}} \\
& \begin{array}{c} \text{---} \otimes \text{---} + \text{---} \text{---} \\ 1 + \text{---} \end{array} \\
& \overline{\overline{1 + \text{---}}}
\end{aligned} \tag{15}$$