diagrams

Basic diagram notation:

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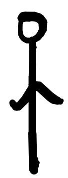
$a_p \equiv$ 

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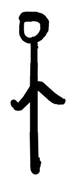
$a_p \equiv$ 

$a_p^\dagger \equiv$ 

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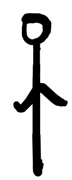
$a_p \equiv$ 

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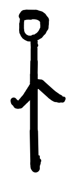
$a_p \equiv$ 

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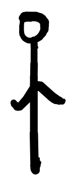
$a_p \equiv$ 

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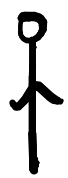
$a_p \equiv$ 

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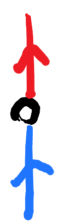
$a_p^\dagger a_q \equiv$ 

$\overbrace{a_p \, a_q^\dagger} \equiv$ 

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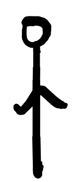
$a_p \equiv$ 

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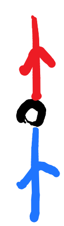
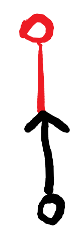
$a_p^\dagger a_q \equiv$ 

$a_p a_q^\dagger \equiv$ 

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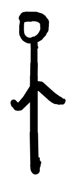
$a_p \equiv$ 

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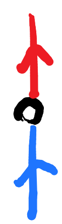
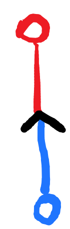
$a_p^\dagger a_q \equiv$ 

$\overline{a_p a_q^\dagger} \equiv$ 

Quasiparticles:

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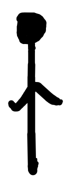
$b_a \equiv$ 

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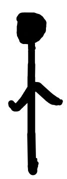
$b_a \equiv$  $\quad b_a^\dagger \equiv$ 

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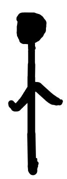
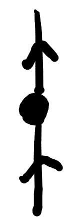
$b_a \equiv$  $\quad b_a^+ \equiv$  $\quad b_a^+ b_b \equiv$ 

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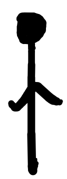
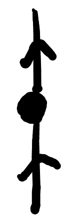
$b_a \equiv$  $b_a^\dagger \equiv$  $b_a^\dagger b_b \equiv$  $b_a b_b^\dagger \equiv$ 

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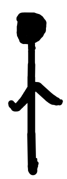
$b_a \equiv$ 

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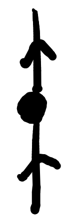
$b_a^\dagger b_b \equiv$ 

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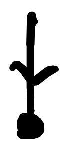
$b_i^\dagger \equiv$ 

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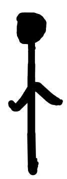
$b_a \equiv$ 

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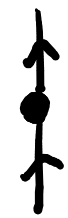
$b_a^\dagger b_b \equiv$ 

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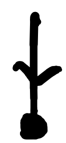
$b_i^\dagger \equiv$ 

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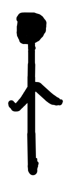
$b_a \equiv$ 

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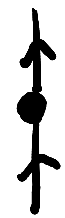
$b_a^\dagger b_b \equiv$ 

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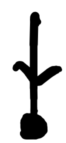
$b_i^\dagger \equiv$ 

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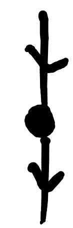
$b_i b_j^\dagger \equiv$ 

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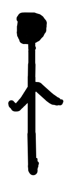
$b_a \equiv$ 

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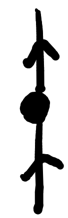
$b_a^\dagger b_b \equiv$ 

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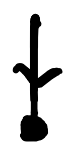
$b_i^\dagger \equiv$ 

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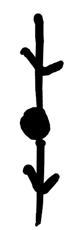
$b_i \, b_j^\dagger \equiv$ 

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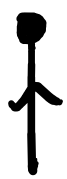
$b_a \equiv$ 

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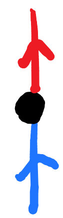
$b_a^\dagger b_b \equiv$ 

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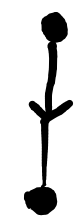
$b_i b_j^\dagger \equiv$ 

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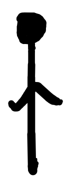
$b_a \equiv$ 

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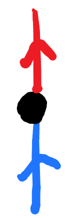
$b_a^\dagger b_b \equiv$ 

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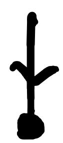
$b_i^\dagger \equiv$ 

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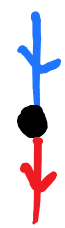
$b_i b_j^\dagger \equiv$ 

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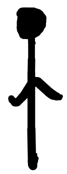
$b_a \equiv$ 

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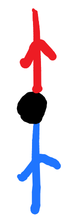
$b_a^\dagger b_b \equiv$ 

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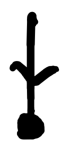
$b_i^\dagger \equiv$ 

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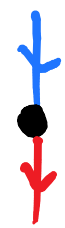
$b_i b_j^\dagger \equiv$ 

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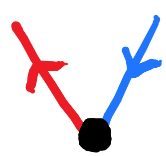
$b_a^\dagger b_i^\dagger \equiv$ 

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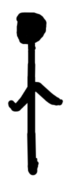
$b_a \equiv$ 

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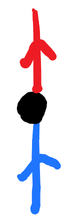
$b_a^\dagger b_b \equiv$ 

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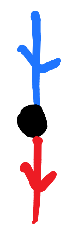
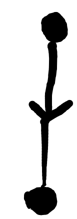
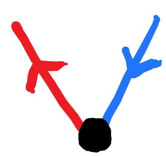
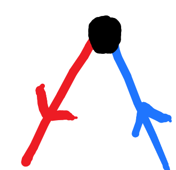
$b_i \, b_j^\dagger \equiv$ 

$\overbrace{b_i \, b_j^\dagger} \equiv$ 

$b_a^\dagger b_i^\dagger \equiv$ 

$b_i \, b_a \equiv$ 

Excitation operators:

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$$:a^{p_1}_{q_1} a^{p_2}_{q_2} \cdots a^{p_n}_{q_n}:$$

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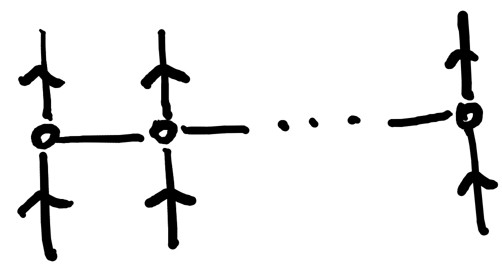
$$:a^{p_1}_{q_1} a^{p_2}_{q_2} \cdots a^{p_n}_{q_n}: \; =$$ 

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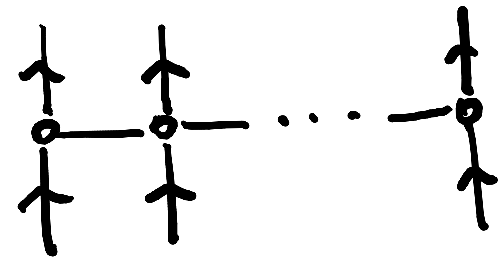
$$:a^{p_1}_{q_1} a^{p_2}_{q_2} \cdots a^{p_n}_{q_n}: \;=\;$$ 

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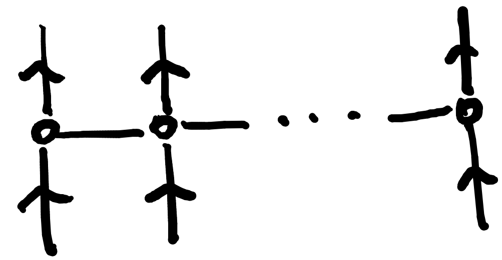
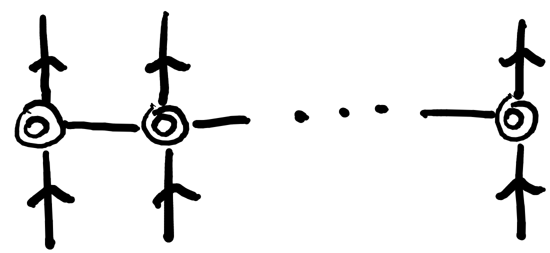
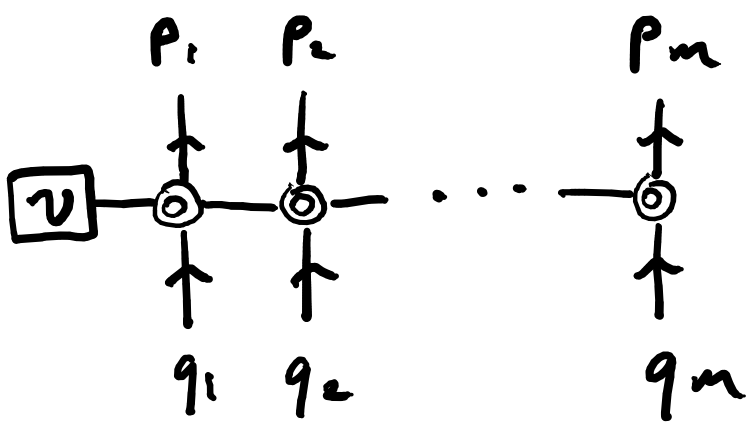
$$:a^{p_1}_{q_1} a^{p_2}_{q_2} \cdots a^{p_n}_{q_n}: \; =$$ 

$$:a^{p_1}_{q_1} a^{p_2}_{q_2} \cdots a^{p_n}_{q_n}: \; =$$ 

n-electron operators:

m-electron operators:



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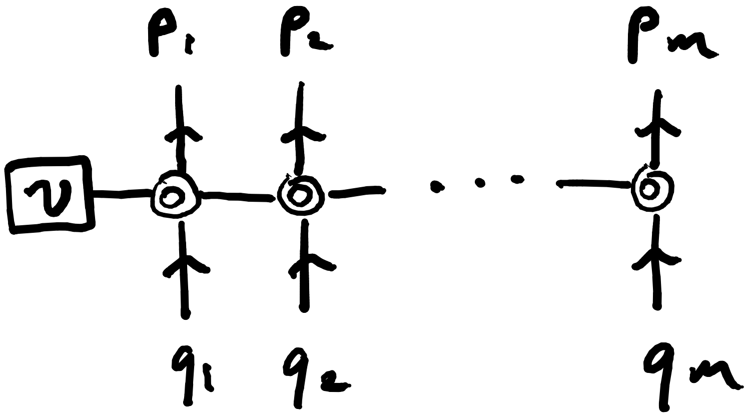

$$\equiv \quad \bar{v}^{q_1 \cdots q_m}_{p_1 \cdots p_m} \, \tilde{a}^{p_1 \cdots p_m}_{q_1 \cdots q_m} \quad \left(\begin{array}{c}\text{no} \\ \text{summation}\end{array}\right)$$

n-electron operators:

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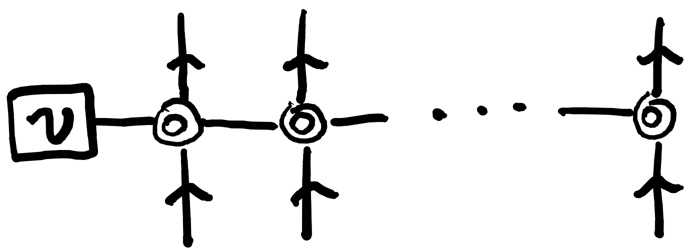

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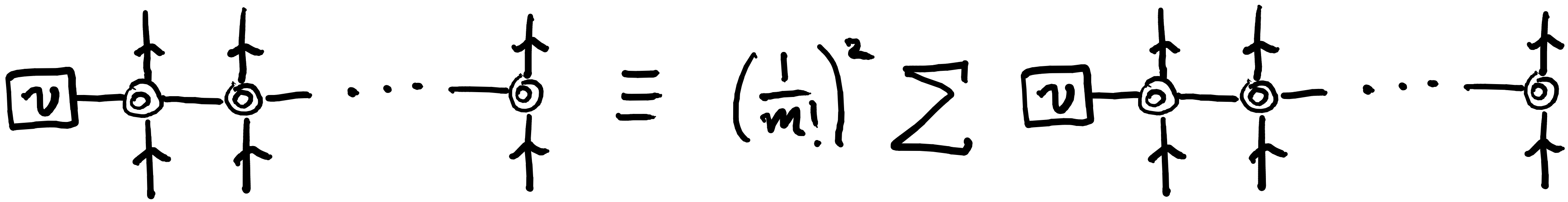

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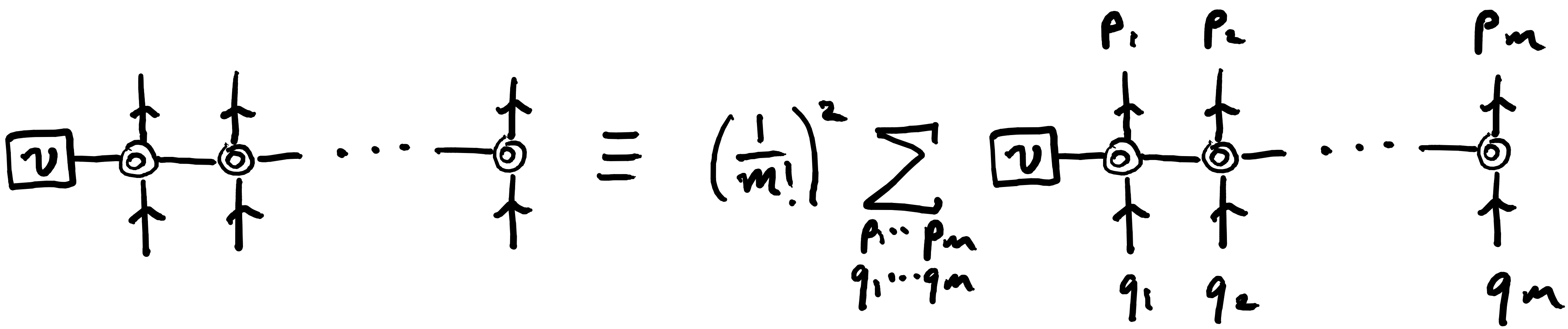

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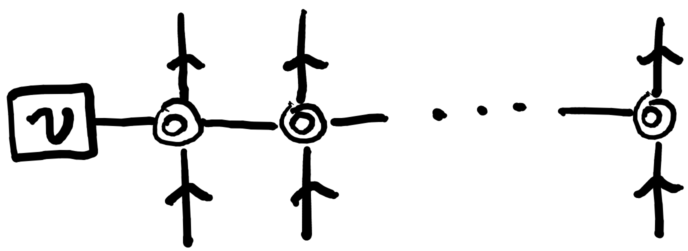
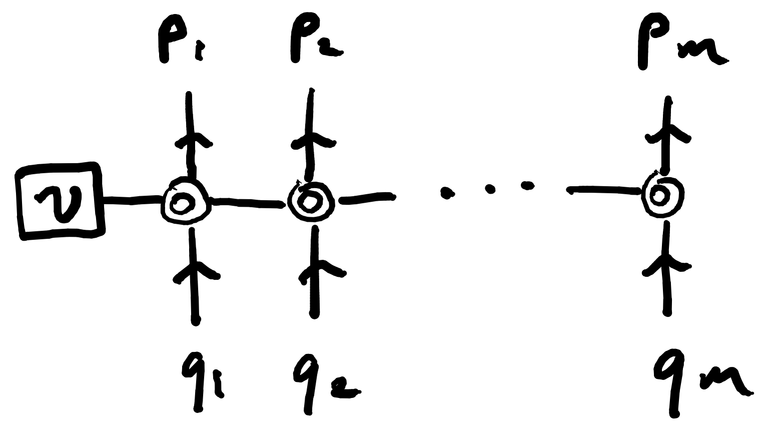
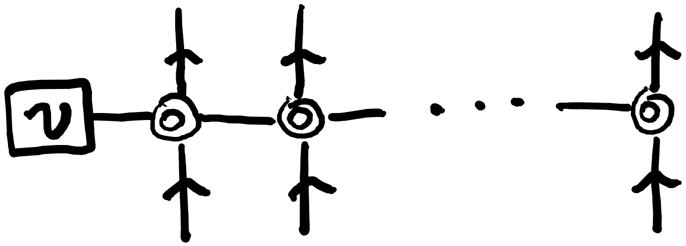


$$\equiv \left(\frac{1}{m!}\right)^2 \sum_{\substack{p_1 \cdots p_m \\ q_1 \cdots q_m}}$$

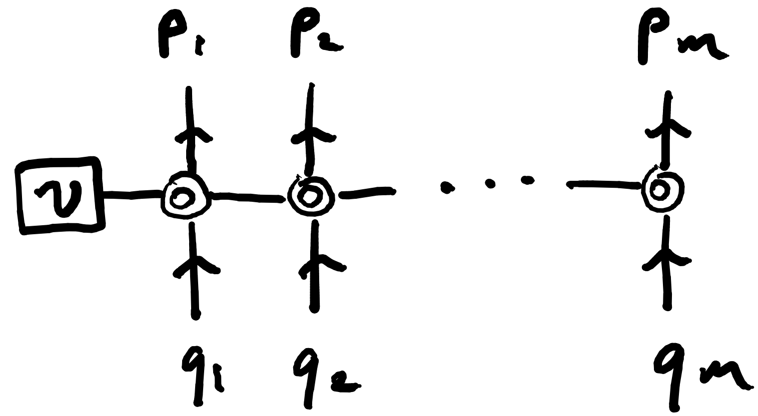


$$= \left(\frac{1}{m!}\right)^2 \sum_{\text{Einstein}} \bar{v}^{q_1 \cdots q_m}_{p_1 \cdots p_m} \, \tilde{a}^{p_1 \cdots p_m}_{q_1 \cdots q_m}$$

m-electron operators:



$$\equiv \left(\frac{1}{m!}\right)^2 \sum_{\substack{p_1\cdots p_m \\ q_1\cdots q_m}}$$



$$= \left(\frac{1}{m!}\right)^2 \sum_{\text{Einstein}} \bar{v}^{q_1\cdots q_m}_{p_1\cdots p_m} \, \tilde{a}^{p_1\cdots p_m}_{q_1\cdots q_m}$$

summation and scalar factor are <u>built</u> <u>in</u> to the notation

alternative notations:

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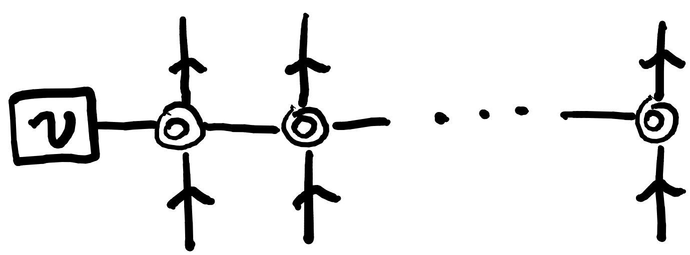
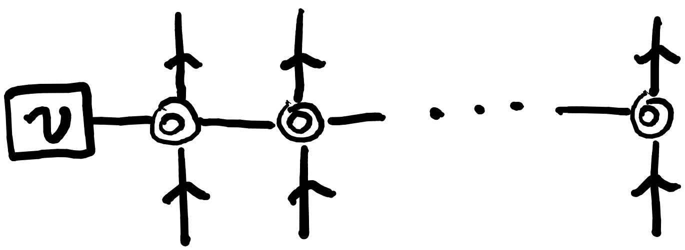
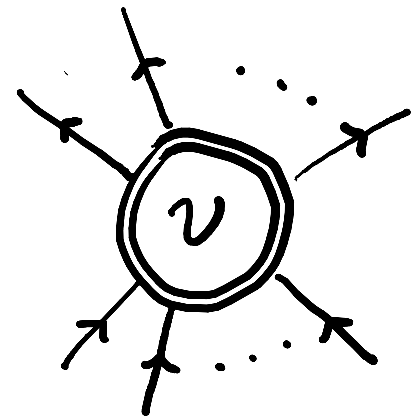


Goldstone

alternative notations:



Goldstone



Hugenholtz

graph:

graph: a product of n-electron ops

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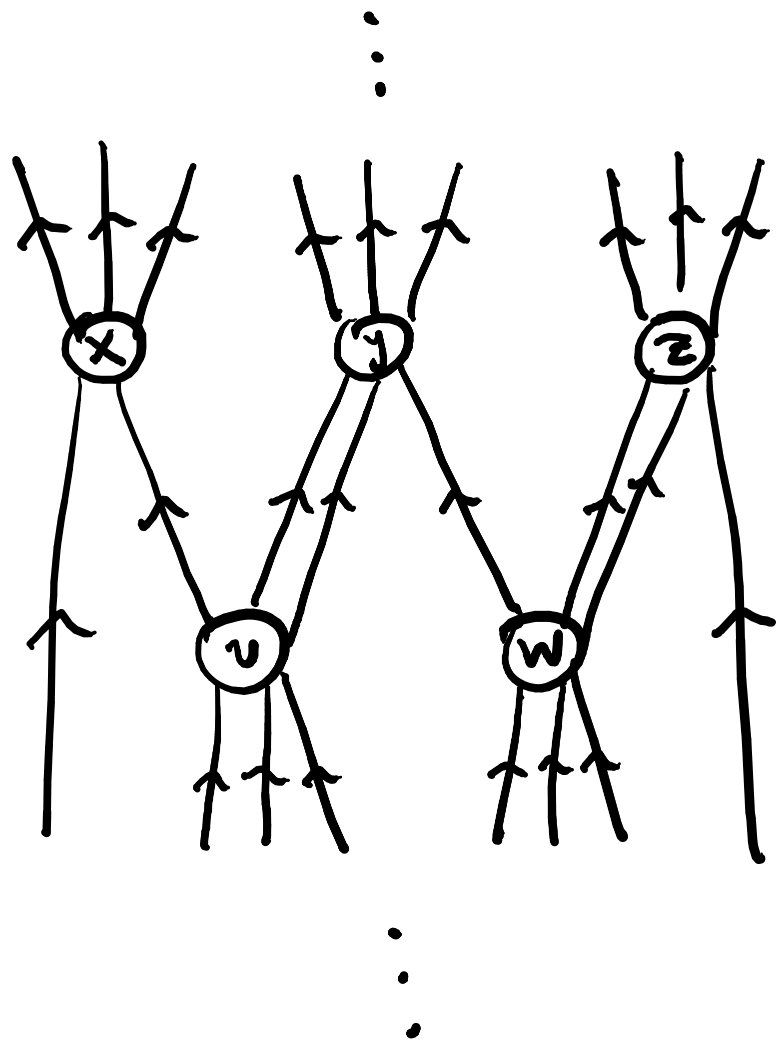

universal rule for interpreting graphs:

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graph

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graph =

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$$\text{graph} = \frac{1}{\#\,\text{permutational symmetries}}$$

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$$\text{graph} = \frac{1}{\#\,\text{permutational symmetries}} \quad \begin{array}{c}\text{labeled}\\ \text{graph}\end{array}$$

universal rule for interpreting graphs:

$$\text{graph} = \frac{1}{\#\text{permutational symmetries}} \sum_{\text{labels}} \text{labeled graph}$$

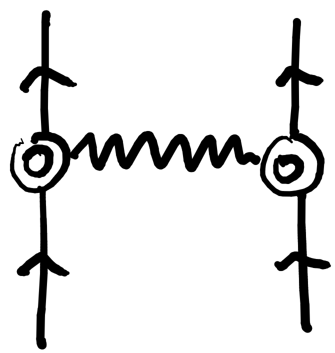
universal rule for interpreting graphs:

$$\text{graph} = \frac{1}{\#\,\text{permutational symmetries}} \sum_{\text{labels}} \text{labeled graph}$$

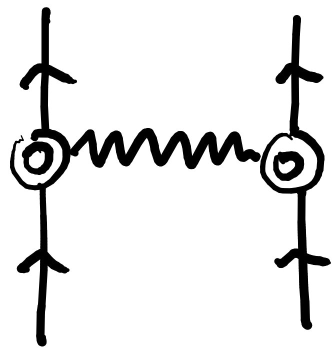
directly translates into an algebraic expression

Examples:

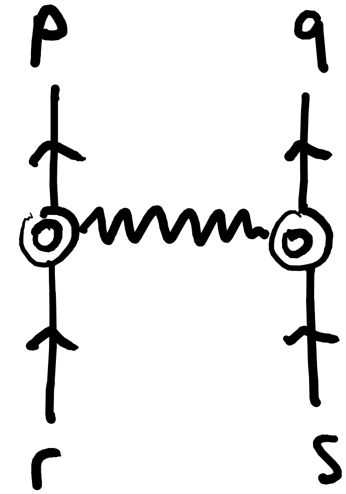
Examples:



Examples:

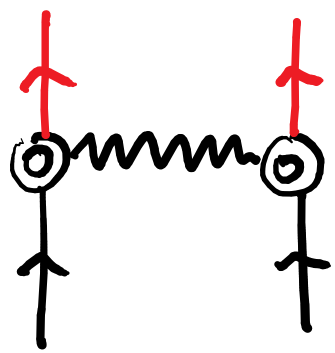


$$= \sum$$

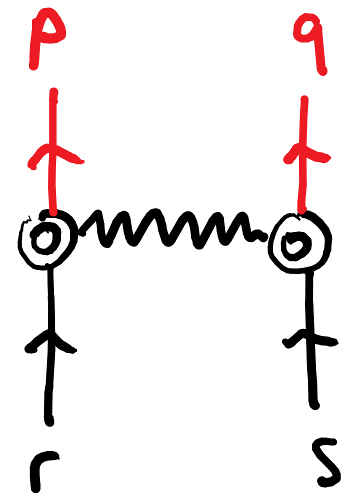


$$= \sum \bar{g}_{pq}^{rs} \, \tilde{a}^{pq}_{rs}$$

Examples:

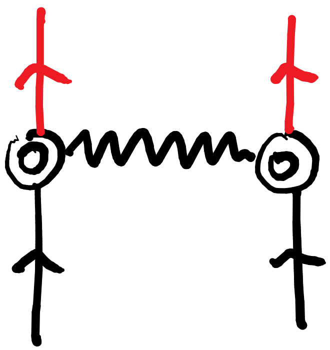


$=\ \sum$

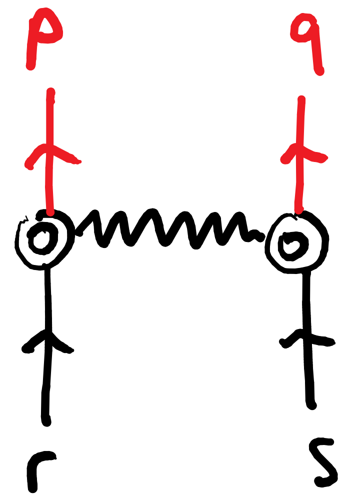


$$= \sum \bar{g}^{rs}_{pq}\, \tilde{a}^{pq}_{rs}$$

Examples:

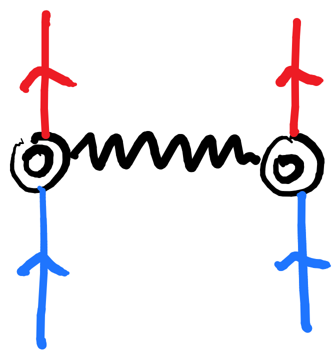


$$= \frac{1}{2}\sum$$

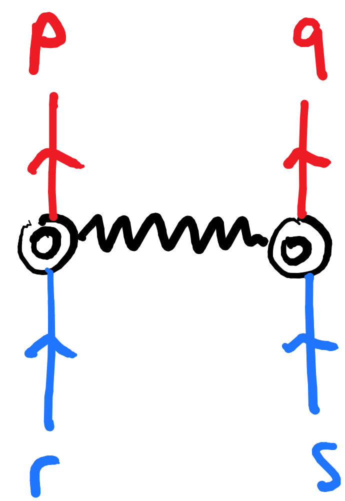


$$= \frac{1}{2}\sum \bar{g}^{rs}_{pq}\, \tilde{a}^{pq}_{rs}$$

Examples:

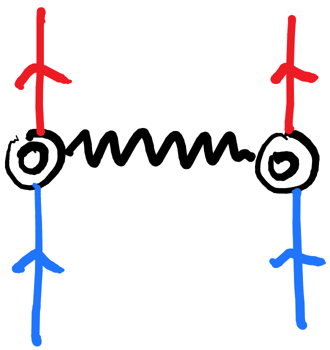


$$= \frac{1}{2} \sum$$

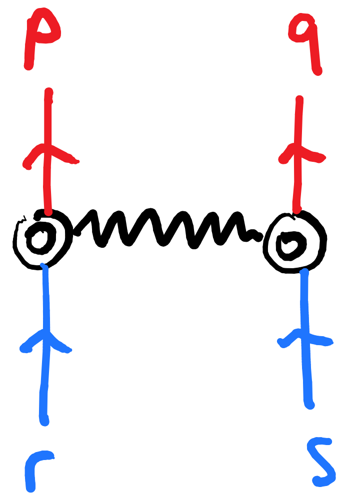


$$= \frac{1}{2} \sum \bar{g}_{pq}^{rs} \, \tilde{a}^{pq}_{rs}$$

Examples:



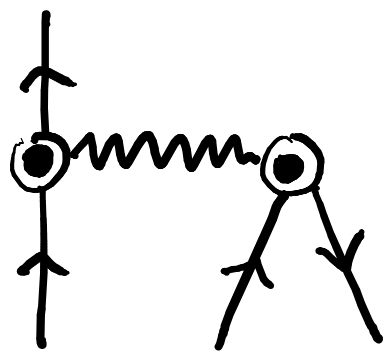
$$= \frac{1}{2\cdot 2}\sum$$



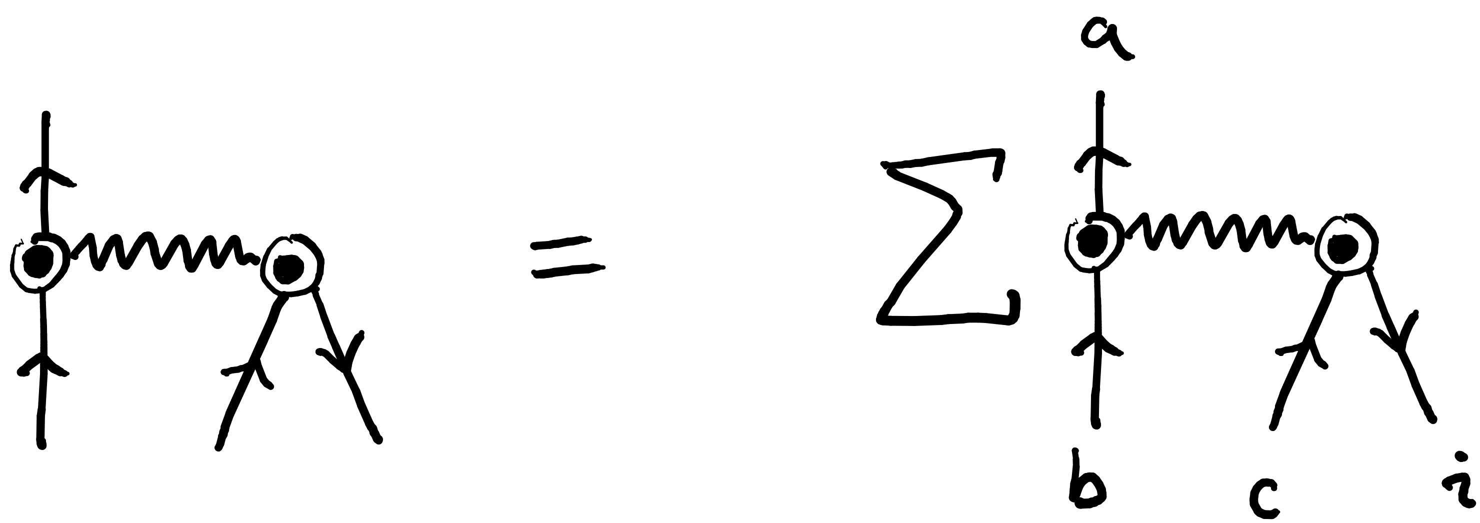
$$= \frac{1}{2\cdot 2}\sum \bar{g}_{pq}^{rs}\,\tilde{a}^{pq}_{rs}$$

Examples:

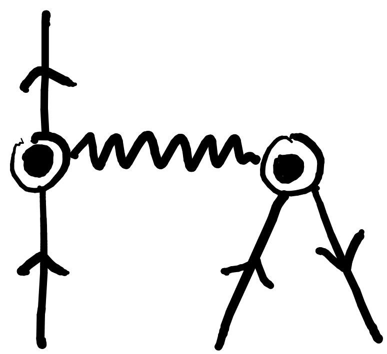
Examples:



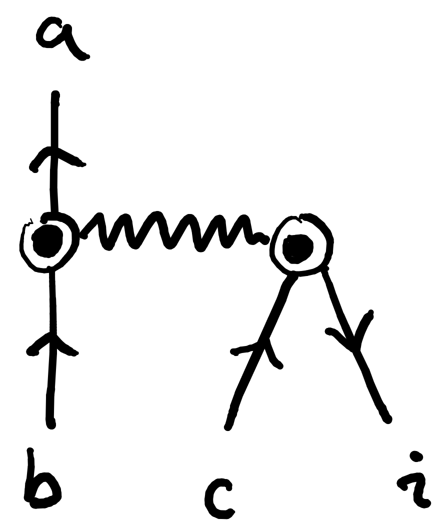
Examples:



Examples:

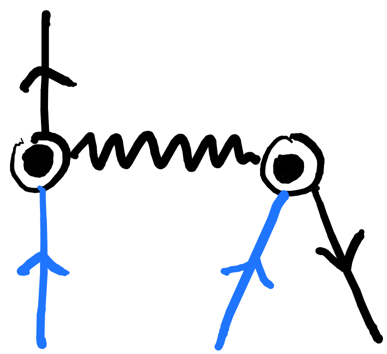


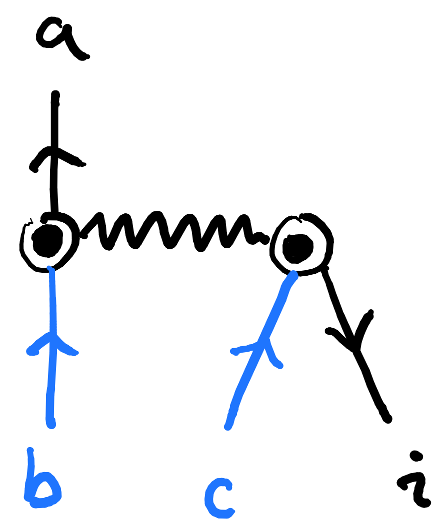
$$= \sum$$



$$= \sum \bar{g}_{ai}^{bc}\, \tilde{a}^{ai}_{bc}$$

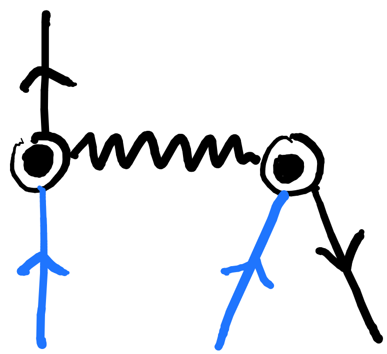
Examples:



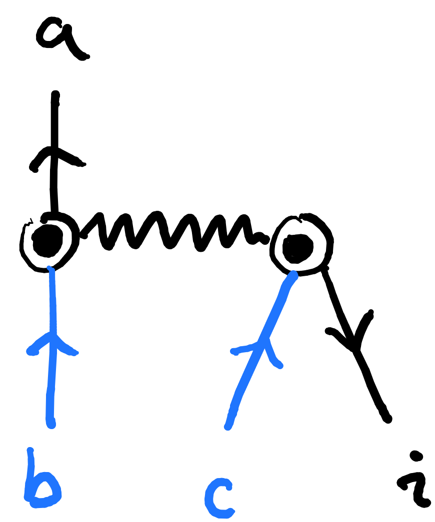
$= \sum$ 

$$= \sum \bar{g}^{bc}_{ai} \, \tilde{a}^{ai}_{bc}$$

Examples:



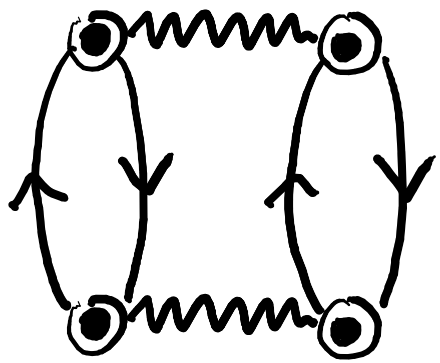
$$= \frac{1}{2} \sum$$



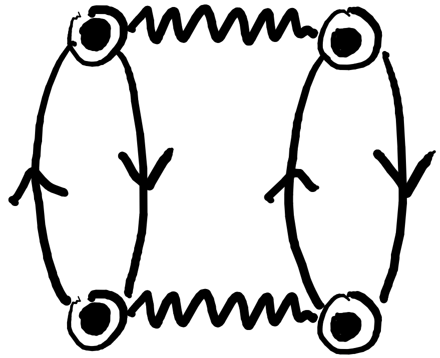
$$= \frac{1}{2} \sum \bar{g}_{ai}^{bc} \, \tilde{a}^{ai}_{bc}$$

Examples:

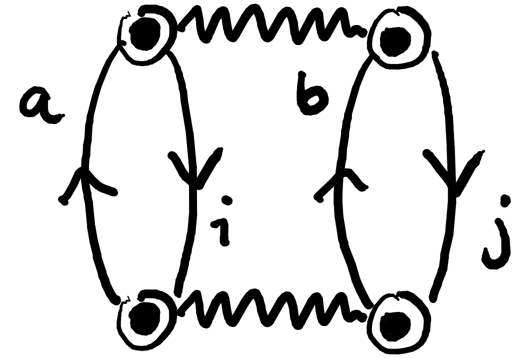
Examples:



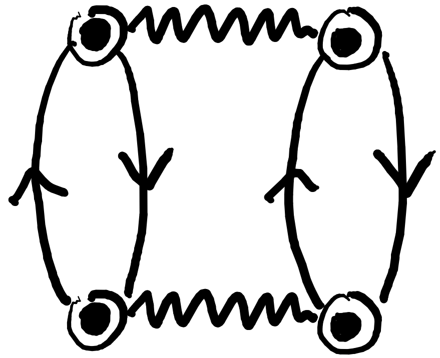
Examples:



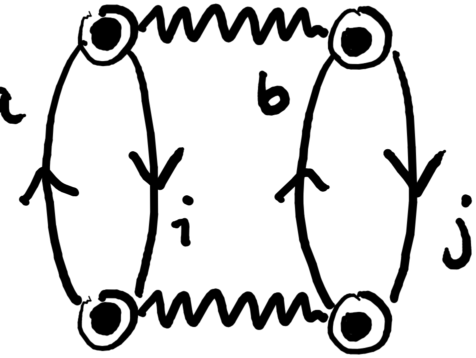
$=$ $\sum$



Examples:

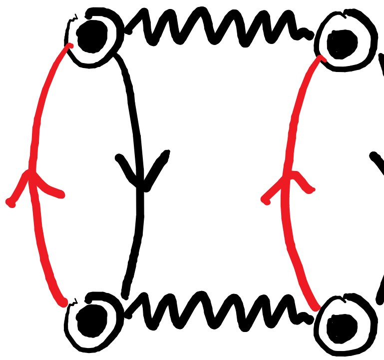


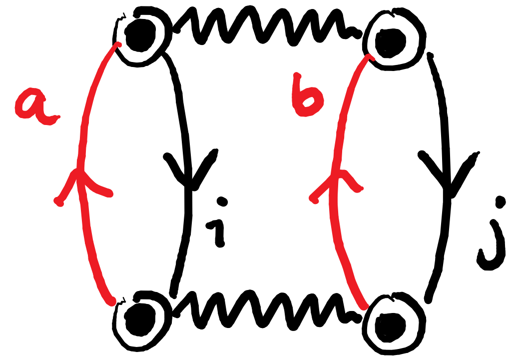
$= \sum$



$$= \sum \bar{g}^{ab}_{ij}\,\bar{g}^{ij}_{ab}\,:a^{i^{\circ}\,j^{\circ\circ}}_{a^{\bullet}\,b^{\bullet\bullet}}\,a^{a^{\bullet}\,b^{\bullet\bullet}}_{i^{\circ}\,j^{\circ\circ}}:$$

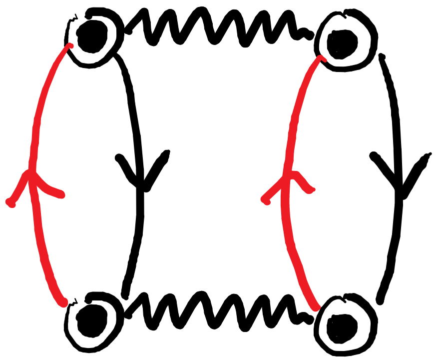
Examples:



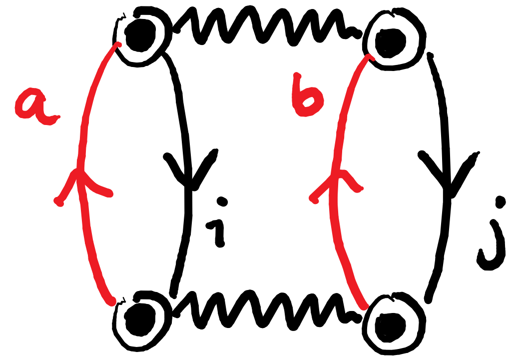
$=$ $\sum$ 

$$= \sum \bar{g}^{ab}_{ij}\, \bar{g}^{ij}_{ab} : a^{i^\circ j^{\circ\circ}}_{a^\bullet b^{\bullet\bullet}}\, a^{a^\bullet b^{\bullet\bullet}}_{i^\circ j^{\circ\circ}} :$$

Examples:

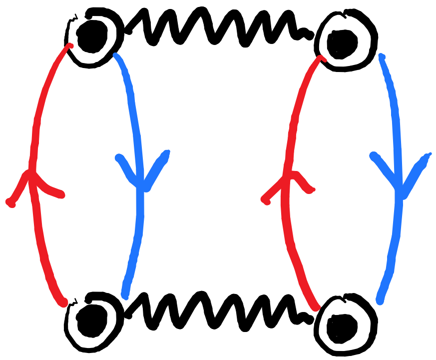


$$= \frac{1}{2\cdot} \sum$$

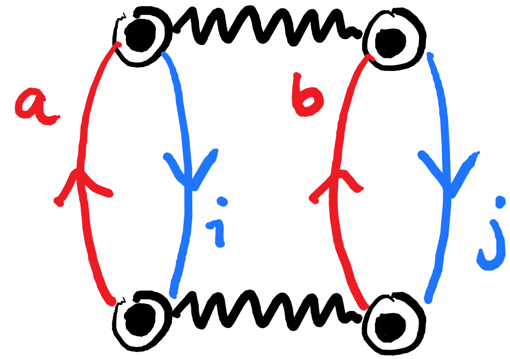


$$= \frac{1}{2\cdot} \sum \bar{g}_{ij}^{ab}\, \bar{g}^{ij}_{ab} \, : a^{i^{\circ} j^{\circ\circ}}_{a^{\bullet} b^{\bullet\bullet}} \, a^{a^{\bullet} b^{\bullet\bullet}}_{i^{\circ} j^{\circ\circ}} :$$

Examples:

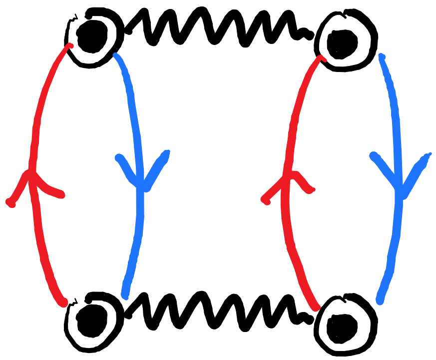
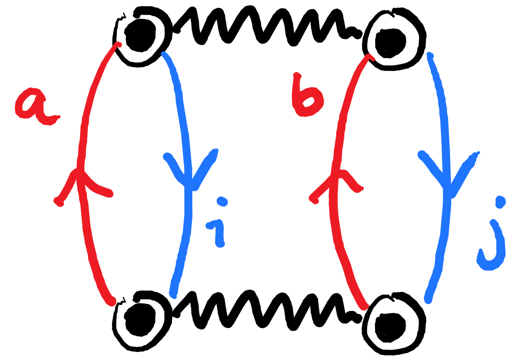


$$= \frac{1}{2\cdot} \sum$$



$$= \frac{1}{2\cdot} \sum \bar{g}^{ab}_{ij} \, \bar{g}^{ij}_{ab} \, : a^{i^\circ \, j^{\circ\circ}}_{a^\bullet \, b^{\bullet\bullet}} \, a^{a^\bullet \, b^{\bullet\bullet}}_{i^\circ \, j^{\circ\circ}} :$$

Examples:

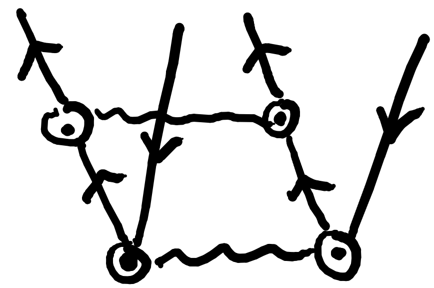
 $= \frac{1}{2\cdot 2}\sum$ 

$$= \frac{1}{2\cdot 2}\sum \bar{g}^{ab}_{ij}\,\bar{g}^{ij}_{ab}\; : a^{i^{\circ} j^{\circ\circ}}_{a^{\bullet} b^{\bullet\bullet}}\, a^{a^{\bullet} b^{\bullet\bullet}}_{i^{\circ} j^{\circ\circ}} :$$

Now you try!

Now you try!

1.



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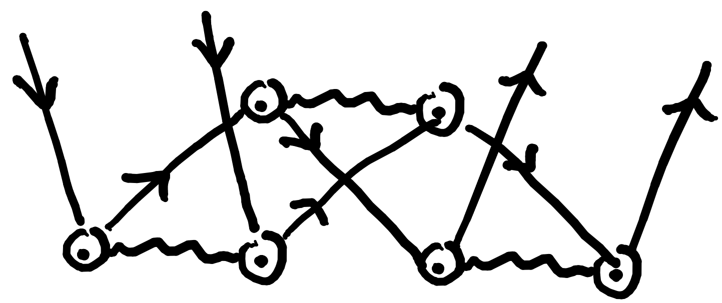

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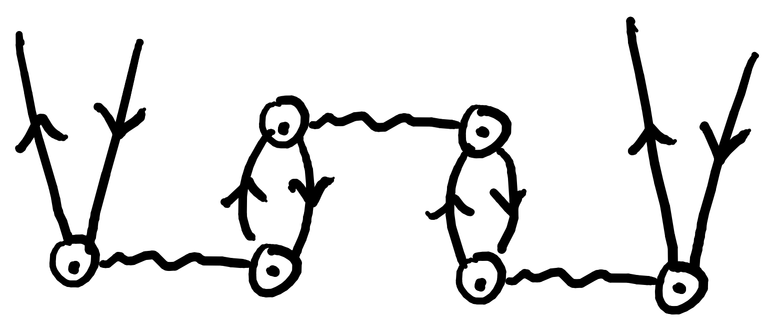

the end.