

Homework for Lecture 7.1 Wick's Theorem

1. Practice translating the following algebraic expressions into a diagrammatic form:

$$a_p^q$$

$$\tilde{a}_p^q$$

$$a_{pq}^{rs}$$

$$\tilde{a}_{pqr}^{stu}$$

$$\tilde{a}_i^a$$

$$\tilde{a}_a^i$$

$$\tilde{a}_{ab}^{ij}$$

$$\tilde{a}_{ijk}^{abc}$$

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

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

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

$$\overline{a_p a_q}$$

2. Practice translating the following matrix elements into diagrams and writing down the resulting fully contracted diagrams:

$$\langle \Phi | h_p^q \tilde{a}_q^p | \Phi \rangle$$

$$\langle \Phi | h_p^q \tilde{a}_q^p | \Phi_i^a \rangle$$

$$\langle \Phi_j^b | h_p^q \tilde{a}_q^p | \Phi_i^a \rangle$$

$$\langle \Phi | h_p^q \tilde{a}_q^p | \Phi_{ij}^{ab} \rangle$$

$$\langle \Phi_j^b | \Phi_i^a \rangle$$