Second Quantization Review

Raising/Lowering Operators

$$\hat{c}^\dagger |n\rangle = \sqrt{n+1}\,|n+1\rangle$$

$$\hat{c}\,|n\rangle = \sqrt{n}\,|n-1\rangle$$

$$\hat{N}\,|n\rangle \equiv \hat{c}^\dagger \hat{c}\,|n\rangle = n\,|n\rangle$$

$$\hat{c}^\dagger\,|n_{\max}\rangle = 0$$

Bosonic form gives the "ladder operator" solution to the harmonic oscillator

Second Quantization Review

Bosons: Canonical Commutation Rules

$$\left[\hat{b}_i^\dagger, \hat{b}_j\right] = \delta_{ij} \qquad \left[\hat{b}_i, \hat{b}_j\right] = 0$$

Fermions: Canonical *Anti*commutation Rules

$$\left\{\hat{a}_i^\dagger, \hat{a}_j\right\} = \delta_{ij} \qquad \{\hat{a}_i, \hat{a}_j\} = 0$$

(Leads to "normal order" terms in matrix elements)