Physics 6433, Quantum Field Theory
Assignment #3
Due Monday, February 16, 2015

February 10, 2015

1. How is the calculation of the transformation function for the harmonic oscillator, $\langle a^{\dagger\prime}, t_1 | a'', t_2 \rangle$, given in class, modified when the zero-point energy, $H_0 = \frac{1}{2}\omega$, is included in the Hamiltonian? What is the effect on the energy eigenvalues and the energy eigenfunctions?

2. From the relation between annihilation eigenvectors and energy eigenvectors,

$$|a'\rangle = \sum_{n=0}^{\infty} \frac{(a')^n}{\sqrt{n!}} |n\rangle,$$
$$\langle a^{\dagger\prime}| = \sum_{n=0}^{\infty} \langle n| \frac{(a^{\dagger\prime})^n}{\sqrt{n!}},$$

deduce a closed form for $\langle a^{\dagger\prime} | a'' \rangle$ analogous to

$$\langle p' | q' \rangle = \frac{1}{\sqrt{2\pi}} e^{-ip'q'}$$

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3. Using

$$G_q - G_p = \delta \left(\sum_a q_a . p_a \right),$$

write $\delta \langle q' | p' \rangle$, and evaluate $\langle q' | p' \rangle$.