Problem Set 6 (Due: Nov. 2, 2011)

October 26, 2011

Your homework should be submitted to TA (Chih-Han Lin) at the beginning of the course. Generally, You have a week to finish the problem set since it was revealed. If you cannot submit it on time, you can still bring your homework to TA's office (L325, Institute of Atomic and Molecular Sciences, in NTU campus) and put it into TA's mailbox which is on the top of the shoe cabinet in L325. Always remember to remind TA to check your homework by e-mail (`clin@ltl.iams.sinica.edu.tw`) if you don't submit it in class.

Ex 1

Find the quantum uncertainty $\Delta\boldsymbol{\xi}\Delta\boldsymbol{p}_\xi$ in the n-particle state (or the n-th excited state) of one-dimensional oscillator.

Ex 2

Show that

$$\langle 0|e^{ikx}|0\rangle = \exp(-\frac{k^2}{2}\langle 0|\mathbf{X}^2|0\rangle),$$

where $|0\rangle$ is the ground state of the one dimensional harmonic oscillator, and $\mathbf{X}$ is the position operator.

Ex 3

The Hermite polynomials $H_n(x)$ may also be defined by the generating function

$$F(h, x) = e^{2hx-h^2} = \sum \frac{1}{n!}H_n(x)h^n.$$

Show that the above definition of $H_n(x)$ is consistant with

$$H_n(x) = (-1)^n e^{x^2}\left(\frac{d}{dx}\right)^n e^{-x^2}.$$