Homework for Advanced Quantum Mechanics

No. 1
Deadline 2016-10-12 before class

Note. Several things you should remember:

1. Late submission of the homework is **NOT** accepted!
2. You should use **English** to answer these questions.
3. Homework written by TEX has 5 extra points as bonus. Please send the pdf file to my email: `mengf@mail.sustc.edu.cn`
4. The total score of each homework is upper bounded by 100 points.
5. Plagiarization is strictly prohibited.

Problem 1. (50 pts) Describe and explain (or define) the following concepts.

1. Photoelectric effect.
2. Compton effect.

Problem 2. (50 pts)

Consider the wave function $\Psi(x,t) = Ae^{-\lambda|x|}e^{-iwt}$, where A, λ, w are positive real constants.

1. Normalize Ψ to find A.
2. Determine the expectation value of x and x^2.
3. Find the standard deviation σ of x.
4. Sketch the graph of $|\Psi|^2$, as a function of x, and mark the points $\langle x\rangle + \sigma$ and $\langle x\rangle - \sigma$, to illustrate the sense in which σ represents the "spread" in x. where $\langle . \rangle$ represents the expectation value of.
5. What is the probability that the particle would be found outside this range $(\langle x\rangle - \sigma, \langle x\rangle + \sigma)$?

Problem 3. (For bonus 5 pts)

Derive by yourself the Compton shift formula. $\Delta\lambda = \frac{h}{mc}(1-\cos\phi)$.