國立彰化師範大學 101 學年度碩士班招生考試試題

系所：物理學系　　組別：甲、乙組　　科目：近代物理

☆☆請在答案卷上作答☆☆　　

1. State the Nobel Prize Laureates in Physics last year (2011) and their contribution. (10%)

2. A particle has a lifetime of 2×10^{-8} s when measured at rest. Suppose one such particle is created in the speed of $0.99c$, where $c = 3 \times 10^{8}$ m/s is the speed of light. How far can it travel before decay? (10%)

3. What is the uncertainty principle in Quantum Mechanics? Prove its mathematical form from the commutation relation. (20%)

4. A particle with mass m in a one dimensional box with infinitely high walls at $x = -D/2$ and $x = D/2$ is initially in the state $\psi(x,0) = [\psi_1(x)+\sqrt{3}\psi_2(x)]/2$, where ψ_1 and ψ_2 are the ground state and the first excited state, respectively.
   (a) Start with the Schrödinger equation, show that $\psi_1(x) = \sqrt{2/D}\cos(\pi x/D)$ and $\psi_2(x) = \sqrt{2/D}\sin(2\pi x/D)$ in $-D/2 < x < D/2$, and find the associated eigen-energies. (20%)

   (b) Write down the explicit expression for $\psi(x,t)$ at $t > 0$, find the expectation value of position $\langle \hat{x}(t) \rangle$ for the particle. (20%)

5. Explain what the band in condensed matter physics is. How does the band gap arise? How do we classify the conductors and the insulators from the band theory? (20%)