國立嘉義大學九十六學年度

光電暨固態電子研究所碩士班招生考試（甲組）試題

科目：近代物理

1. 名詞解釋：（20%）
   (a) Larmor precession
   (b) Bohr magneton
   (c) Boson
   (d) Exchange force
   (e) Fermi energy

2. An electron of a hydrogen atom is in a state described by the wave function:

$$\tfrac{1}{9}[3\psi_{100}(\vec{r}) + 7\psi_{200}(\vec{r}) - 2\psi_{211}(\vec{r}) + 4\psi_{210}(\vec{r}) + \sqrt{3}\psi_{21-1}(\vec{r})]$$

   Please answer the following questions from the above function,
   (a) What is the expectation value of the total energy?
   (b) What is the expectation value of the square of angular momentum? （20%）

3. (a) From the number of allowed frequencies *N(v)* within frequency interval *dv*, i.e. *N(v)dv*, derive the total radiation energy per unit *volume* in the black-body cavity by the *Planck* postulate. (b) Using the result of (a) to derive the *Wien* displacement relation that the maximum wavelength λ_{max} is equal to *b*/T, where *b* is a constant. （20%）

4. Plot the Zeeman effect energy splitting for the ground and the lowest-excited energy level of the ^{11}Na atom. You must calculate the energy splitting and draw to scale. Label the levels with spectroscopic notation, and clearly indicate the splitting level with m_j. (In this case, the external magnetic field is smaller than the atomic magnetic field.) （20%）

5. (a) Find the normalized symmetric eighenfunction $\psi_S(\vec{r}_1, \vec{r}_2, \vec{r}_3)$ for a system of three noninteracting identical particles without any spin. (The eigenfunction for each particle can be written as $\psi_\alpha(\vec{r}_i)$, $\psi_\beta(\vec{r}_i)$, $\psi_\gamma(\vec{r}_i)$, i = 1, 2, 3.) (b) Also find $\psi_S(\vec{r}_1, \vec{r}_2, \vec{r}_3)$ when $\vec{r}_1 \approx \vec{r}_2 \approx \vec{r}_3$, and make comments on the resulting expression by comparing it with the case for three distinguishable particles.（20%）