Modern Physics

1. A π^+ meson at rest decays into a μ^+ meson and a neutrino in 2.5×10^{-8} seconds. Assume now that this π^+ meson has kinetic energy equal to its rest energy.

(a) What is the velocity of the meson?

(b) What distance would the meson travel before decaying, as seen by an observer at rest? (15 points)

2. Prove that the minimum photon energy required to produce an electron–positron pair in the neighborhood of an electron is $4m_oc^2$. (15 points)

3. (a) Why is it that in order to observe the spin $\frac{1}{2}$ character of the electron in the Stern–Gerlach experiments one must use beams of atoms all in the ground state and belonging to the first group of the periodic system?

(b) Why is it that in this experiment the spin of the nucleus does not interfere with the observation of the spin of the electron? (15 points)

4. (a) From considerations of equilibrium, derive the following relation between the orbital radius and the angular velocity of the electron in doubly ionized lithium:

$$r = \frac{912}{\omega^2 73} \quad \text{(CGS units)}$$

(b) Using the formula of part (a), apply Bohr's postulate on angular momentum to find the minimum orbital radius. (15 points)

5. Write out the complete electronic configuration for thallium (Z=81). Express the lowest energy state using the conventional spectroscopic notation, giving also all the possible values of J. (15 points)

6. Write the mass formula suggested by liquid drop model and explain the meaning for each term in the formula. (15 points)

7. If the decay mode $\rho^o \longrightarrow \pi^+ + \pi^-$ is a strong interaction. The spins of ρ and π are 1 and 0 respectively. What could be the parity of ρ^0 ? (10 points)