Homeworkproblems 3

Exercise 1:

a) Calculate the spectrum corresponding to a spin 1/2 particle with magnetic moment $\vec{\mu} = gq/(2mc)\vec{s}$ situated in a magnetic field $\vec{B} = B_x\vec{i} + B_y\vec{j}$ where B_x and B_y are constants.

b) Which is the probability that in the lowest state thus calculated the spin projection of the particle is measured to be s_z=-1/2.

Exercise 2:

a) In the Rabi formula one has to assumme $|B_1/B_0| \ll 1$. Why?.

b) Show that $d(t)$ (Eq. (9) in Chapter 2) is solution of Eq. (8).

Exercise 3:

Consider medical applications of Magnetic Resonance Imaging (MRI). In these applications,

a) Only protons are considered, while other heavier isotopes, like ^{16}O, are neglected. Why?.

b) Why are the interferences of electrons also neglected?.

c) The intrinsic spin of the proton is considered to be $\mathbf{j} = \mathbf{s}$. Why?.

Exercise 4:

Which is the width of a MRI resonance if the variable field perpendicular to B_0=1 T is B_1=10 gauss?. How much changes this width if B_0=2 T?.

Exercise 5:

Evaluate ω_0 for a proton in a magnetic field B_0=1.0 T (which is the most common value used in medical applications of MRI). Compare this frequency with the one corresponding to the x-rays in computed tomography (CT), with an energy of 10 keV, and the γ-rays of radiation theraphy, with an energy of 1 MeV.