# Phys 402: Applications of Quantum Mechanics

**Time dependent perturbations Part I**
(Textbook, page 340-348)

Spin as a two-level system

For an electron with spin ½ initially prepared in a spin-up state along the z-direction, or |S_z=1/2> state. A "weak" pulse with strength "A" defined below is applied along the x-direction.

1) When the pulse gets wider or duration t_0 is increased but the strength "A" remains unchanged, the transition to the down state after the pulse is
a) increased; b) decreased; c) unchanged.
Hint: You might want to apply the perturbation theory to evaluate the situation. You can also assume a rectangle shape. How does your conclusion depend on the shape?

2) In this case, the unperturbed Hamiltonian is zero, can one apply the time dependent perturbation theory? When is the first order perturbation applicable?
a) A >> 1; b) A<<1; c) A=1; d) depends on t_0.

****In part 1, luckily one can obtain a full solution for a pulse of arbitrary shape and strength (without using the perturbation theory). Let me know if you are able to find a solution beyond the perturbation method☺.

3) Now assume the z-direction static magnetic field is nonzero.
Discuss qualitatively what happens when the pulse gets wider (but the strength again unchanged). Hints: the amplitude of the x-direction field gets smaller here.