

8.421: Pre-Class Questions February 10, 2020

1. The Lorentz model of an atom resembles a harmonic oscillator. In what limit is this model valid?

- When the saturation effects are negligible, i.e., $P_1 \ll P_0$, where P_0 and P_1 are the populations of the ground, and first excited state respectively.

2. What distinguishes a two-level system from a harmonic oscillator?

- Saturation effects. For the Quantum Harmonic Oscillator model, strong driving leads to the unbounded population of higher excited states. While for 2-level system, the finite number of levels leads to a saturation of the populations across the states.

3. Give a classical analogue of the two-level system.

- The precession of a gyroscope (or any rotating system with limited degrees of freedom)
- Two coupled mechanical oscillators can exhibit Bloch oscillations and even a Landau-Zener type transitions.
- Electron's magnetic dipole moment.

3.b. What aspects are missing from a real quantum system?

- Spontaneous emission.
- Quantum state projection.

4. What is a magnetic moment of an electron in units of Bohr magneton?

- 1 Bohr magneton

5. For systems under precession about a magnetic field, we found that the cyclotron frequency is twice the Larmor frequency. Explain the physical origin of this difference.

- It is the difference between the physics of a free charge and the physics of a magnetic moment.