**Before-class Questions #8:**

**Question 1:** What does the polarizability of a hydrogen atom have in common with a metallic conducting sphere? Do larger atoms have larger polarizabilities?

*Answer:* They both have a polarizability that scales with their volume. Correspondingly, larger atoms will have larger polarizabilities.

**Question 2:** Why is there a breakdown of perturbation theory at very small electric fields for electronically excited states but not the ground state?

*Answer:* Degeneracies found in the excited states can have opposite parities, allowing the dipole matrix element to couple states that are very close in energy.

**Question 3:** How does the critical electric field, where perturbation theory breaks down, scale with electronic number \( n \)? What does this mean for Rydberg atoms?

*Answer:* The critical field scales as \( n^{-5} \), implying that perturbation theory for Rydberg atoms quickly becomes invalid with any significant applied field. Instead, strong level mixing occurs.

**Question 4:** What is typically the method of choice for detecting Rydberg atoms, and why?

*Answer:* State-selective field ionization, due to the \( n^{-4} \) scaling of field required to ionize atoms.

**Question 5:** There is a time-independent and time-dependent way for obtaining the AC Stark shift. The time-dependent method uses an oscillating electric field in a coherent state. What does the time-independent method do differently?

*Answer:* The time-independent approach uses photon Fock states to remove all time dependence, essentially redefining the energy levels as the entire atom+field system rather than just the atom.

**Question 6:** Which quantity is directly proportional to the index of refraction? What effect do the real and imaginary part of index of refraction have on light passing through the medium?