1. Consider an ensemble of atoms, all in the ground state except for one atom in the excited state. How does the initial photon emission rate depend on the atom number N? (Assuming average inter-atomic separation is much smaller than the optical wavelength and a fully symmetric initial state)

A: The initial photon emission rate is proportional to N.

2. For the same situation as in 1.: What is the total number of photons emitted? Does it depend on N?

A: single photon, no dependence on N.

3. For the same geometry as in 1. and 2., but all atoms in the ground state: How does the absorption probability for an incident photon depend on N? Will the absorpiton of a single photon prepare the symmetric state assumed in questions 1. and 2.?

A: proportional to N. It will result in a symmetric state.

4. Superradiance requires the emission of photons to be in the same mode for all atoms involved. Give an example where atoms are not localized to a region smaller than the optical wavelength, but still show superradiance and explain why.

A: There are many, as long as the emission is into a single mode and the coherence time is sufficiently long (such as emitting into the same cavity mode, or atoms in an elongated shape, e.g. a cigar-shpared BEC)

5. Suppose we live in a 1D world (on a line) and we trap an array of atoms along this direction, where adjacent atoms have random separations which are larger than the optical wavelength. The atoms are in a symmetric state, with one excitation. The system will emit a photon, and due to the 1D feature the photon can only be emitted forward or backward. What is the rate for emission of the photon when Gamma is the rate for a single atom?

- N * Gamma, fully superradiant effect. In one direction, the emission of all atoms can be in phase. One can say that the phase for each atom compensates for the propagation phase.