Superradiance and subradiance in atoms near a nanofiber

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We discuss in this talk super and sub radiance in atoms randomly distributed along a nanofiber. Atoms interact between them through the field. Due to this interaction, one excitation shared by an atomic ensemble can decay faster (superradiance) or slower (subradiance) than in the case of independent atoms. When the atoms are near a nanofiber, they interact with each other through the radiated and guided electromagnetic modes given by the nanofiber boundary conditions. The interaction between each other through the radiated mode rapidly decreases with the distance between atoms (at the order of a resonant wavelength), the interaction through the guided mode is not limited by distance.

We study the decay of atoms, randomly distributed along a nanofiber, that are excited by a weak pulse from the side (upper part of figure); this pulse creates an initial state that consist of a superposition of at most one atomic excitation. The phases of this superposition depend on the positions of the atoms. This initial state can be written as a superposition of super and sub radiant states with decay rates that depend on these phases. The histogram of the times between the excitation pulse and the measurement of a photon through the guided modes gives the lifetime of the initial state. The mean of the decay time for different realizations of randomly distributed atoms is compared with experimental results. The signal shows superradiance at short times and subradiance at larger times (bottom part of figure).

We show that superradiance is a signature of interaction, through the guided modes, of atoms far apart, and the large subradiance is due to the interaction, through radiated modes, of atoms close to each other.

Figure 1: Super and sub radiance in atoms interacting near a nanofiber. Adapted from Figs. 1 and 2 of Solano P. et al. Nat. Comm. 8, 1857 (2017)

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