Subradiant collective states in the discrete emitter array. Fermi Golden Rule

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We are interested in the decay rates of the collective polaritonic eigenmodes of a periodic array of N emitters in the waveguide. The decay rates can be formally calculated by a Fermi Golden rule-like expression,

$$2\gamma = 2\pi \int_{-\infty}^{\infty} \frac{\mathrm{d}k}{2\pi} |M_k|^2 \delta(\omega_0 - c|k|), \quad M_k = g \sum_{m=1}^{N} \mathrm{e}^{\mathrm{i}kdm} \psi_m \,, \tag{1}$$

where M_k is the matrix element of the interaction of the state ψ_m with photon with wave vector k , ω_0 is the emitter resonance frequency, d is the array period, g is the coupling constant.

Goal: Calculate the decay rate for the states with

- $\psi_m = \frac{1}{\sqrt{N}}$ (superradiant state)
- $\psi_m = \sqrt{\frac{2}{N}}(-1)^m \sin\frac{\pi(m-1/2)}{N}$ (most subradiant state for $\omega_0 d/c \ll 1$)

Assume that $N \gg 1$. The states are illustrated in the Fig. 1

FIG. 1 Schematics of the spatial profile of the most superradiant (left) and most subradiant modes (right).

REFERENCES