Collective Rabi splitting in a cavity

(Dated: February 17, 2025)

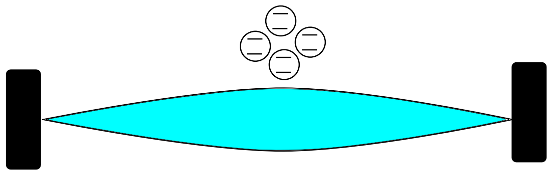

FIG. 1 Schematics of N emitters coupled to a cavity mode

Consider N identical emitters with resonant frequencies ω_0, radiative decay rates $\gamma_{1\mathrm{D}}$, and zero nonradiative decay rates placed in the center of a symmetric cavity and located at the close points z_n. Assume that the emitter-emitter distance is much smaller than the photon wavelength, the cavity size d satisfies the condition $\omega_{\mathrm{cav}}d/c = \pi$ and the mirror reflection coefficient is $r_{\mathrm{mirror}} = \sqrt{1-1/Q}$. Assume that the photon Green function in the general case is known and equal to

$$G(z,z') = \frac{\mathrm{i}}{2q}\left[\mathrm{e}^{\mathrm{i}q|z-z'|} + \frac{2\widetilde{r}}{1-\widetilde{r}^2}[\cos q(z+z') + \widetilde{r}\cos q(z-z')]\right], \quad \widetilde{r} = r_{\mathrm{mirror}}\mathrm{e}^{\mathrm{i}qd}\,. \tag{1}$$

Goal 1. Show that the photon Green function can be approximated as

$$G(z_n,z_m) = \frac{1}{2q}\frac{2\omega_{\mathrm{cav}}}{\omega_{\mathrm{cav}} - \omega - \mathrm{i}\frac{\omega_{\mathrm{cav}}}{2Q}}, \quad n,m = 1\ldots N \tag{2}$$

(Q is the cavity quality factor, $q = \omega_0/c$, ω_{cav} is the cavity resonance frequency).

Goal 2. Find the resonance frequencies of the system.