

Coherent control of two Jaynes-Cummings cavities

Supplementary Information

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A Some useful relations

In this section we explicitly write some of the equations used through out the core text. The expectation values in equation (25) are explicitly given as

$$\text{Re}[\langle T_{ji}^\dagger \sigma_z T_{jj} \rangle] = \cos[(2t - t_m)g_j \sqrt{n_j + 1}] \cos(t_m g_i \sqrt{n_i + 1}), \quad (\text{A-1})$$

and

$$\langle T_{ji}^\dagger \sigma_z T_{jj} \rangle = \cos[2(t - t_m)g_j \sqrt{n_j + 1}] \cos^2(t_m g_i \sqrt{n_i + 1}) - \cos[2(t - t_m)g_j \sqrt{n_j}] \sin^2(t_m g_i \sqrt{n_i + 1}), \quad (\text{A-2})$$

for $i \neq j$.

To compute the photon number and for non-identical cavities (28) the following relations are useful

$$\begin{aligned} \langle T_{jj}^\dagger a_j^\dagger a_j T_{jj} \rangle &= \sin^2(g_j t \sqrt{n_j + 1}) + n_j, \\ \langle T_{ii}^\dagger a_j^\dagger a_j T_{ii} \rangle &= n_j, \\ \text{Re}[\langle T_{ij}^\dagger a_i^\dagger a_i T_{ii} \rangle] &= \cos(g_j t_m \sqrt{n_j + 1}) [\sin(g_i t \sqrt{n_i + 1}) \sin(g_i (t - t_m) \sqrt{n_i + 1}) + n_i \cos(g_i t_m \sqrt{n_i + 1})], \\ \text{Re}[\langle T_{ij}^\dagger a_j^\dagger a_j T_{ii} \rangle] &= n_j \cos(g_i t_m \sqrt{n_i + 1}) \cos(g_j t_m \sqrt{n_j + 1}), \\ \langle T_{ij}^\dagger a_i^\dagger a_i T_{ij} \rangle &= \sin^2[g_i (t - t_m) \sqrt{n_i + 1}] + n_i, \\ \langle T_{ij}^\dagger a_j^\dagger a_j T_{ij} \rangle &= \sin^2(g_j t_m \sqrt{n_j + 1}) + n_j, \end{aligned} \quad (\text{A-3})$$

for $i \neq j$. The coefficients ξ_l in equation (31) are explicitly given as

$$\begin{aligned} \xi_1 &= \cos^3 \theta e^{\phi_0} e^{\phi_0} f_c(n_0 + 1, \Delta_0, g_0, t) + \cos \theta \sin^2 \theta e^{\phi_0} e^{\phi_1} f_c(n_0 + 1, \Delta_0, g_0, t - t_m) f_c(n_1 + 1, \Delta_1, g_1, t_m) \\ \xi_2 &= -\cos \theta \sin^2 \theta e^{\phi_0} e^{\phi_1} h_c(n_0 + 1, \Delta_0, g_0, t - t_m) f_c(n_1 + 1, \Delta_1, g_1, t_m) - h_c(n_0 + 1, \Delta_0, g_0, t) \cos^3 \theta e^{\phi_0} e^{\phi_0}, \\ \xi_3 &= -\cos \theta \sin^2 \theta e^{\phi_0} e^{\phi_1} h_c(n_1 + 1, \Delta_1, g_1, t_m) f_c^*(n_0, \Delta_0, g_0, t - t_m), \\ \xi_4 &= \cos \theta \sin^2 \theta e^{\phi_0} e^{\phi_1} h_c(n_1 + 1, \Delta_1, g_1, t_m) h_c(n_0, \Delta_0, g_0, t - t_m), \\ \xi_5 &= e^{i\varphi} \cos^2 \theta \sin \theta e^{\phi_1} e^{\phi_0} f_c(n_0 + 1, \Delta_0, g_0, t_m) f_c(n_1 + 1, \Delta_1, g_1, t - t_m) + e^{i\varphi} \sin^3 \theta e^{\phi_1} e^{\phi_1} f_c(n_1 + 1, \Delta_1, g_1, t), \\ \xi_6 &= -e^{i\varphi} \cos^2 \theta \sin \theta e^{\phi_1} e^{\phi_0} f_c(n_0 + 1, \Delta_0, g_0, t_m) h_c(n_1 + 1, \Delta_1, g_1, t - t_m) - e^{i\varphi} \sin^3 \theta e^{\phi_1} e^{\phi_1} h_c(n_1 + 1, \Delta_1, g_1, t), \\ \xi_7 &= -e^{i\varphi} \cos^2 \theta \sin \theta e^{\phi_1} e^{\phi_0} h_c(n_0 + 1, \Delta_0, g_0, t_m) f_c^*(n_1, \Delta_1, g_1, t - t_m), \\ \xi_8 &= e^{i\varphi} \cos^2 \theta \sin \theta e^{\phi_1} e^{\phi_0} h_c(n_0 + 1, \Delta_0, g_0, t_m) h_c(n_1, \Delta_1, g_1, t - t_m), \end{aligned} \quad (\text{A-4})$$

where

$$f_c(n_j, \Delta_j, g_j, t) = \cos(t\Omega_j(n_j)) - \frac{1}{2}i\Delta_j \sin(\Omega_j(n_j)t)/\Omega_j(n_j), \quad h_c(n_j, \Delta_j, g_j, t) = -ig_j \sqrt{n_j} \sin(t\Omega_j(n_j))/\Omega_j(n_j),$$

and the operators $e^{\phi_j} = e^{-i\omega_j(n_j+1/2)t_m} e^{-i\omega_{j\oplus 1} a_{j\oplus 1}^\dagger a_{j\oplus 1} t_m}$ and $e^{\phi'_j} = e^{-i\omega_j(n_j+1/2)(t-t_m)} e^{-i\omega_{j\oplus 1} a_{j\oplus 1}^\dagger a_{j\oplus 1} (t-t_m)}$. Notice that, for the resonant case, i.e., $\Delta_0 = \Delta_1 = 0$, the phases e^{ϕ_j} will be cancelled when calculating the probabilities $|\xi_j|^2$.