Rydberg Atom

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1 Hamiltonian

$$\frac{\mathrm{d}\rho}{\mathrm{d}t} = -\frac{i}{\hbar}[\hat{H}, \rho] + L(\rho), \tag{1}$$

in which $\hat{H}$ is the Hamiltonian for the coupled system and $L(\hat{\rho})$ is a Lindblad super-operator providing the resonator's decoherent thermal population. More explicitly,

$$\hat{H} = \hbar\omega_r b^\dagger b + \hbar\omega_a a^\dagger a + \hbar\Omega(a^\dagger b + ab^\dagger) + d_b E(t)(b + b^\dagger) + d_a E(t)(a + a^\dagger) \tag{2}$$

where $\omega_r = 5.4$GHz is the resonator frequency, $\omega_a = 5.5$GHz is the transition frequency of the atom, $\Omega = 3$MHz is the vacuum Rabi frequency, $d_b =?$ and $d_a =?$ are the transition dipole moments of the resonator and the atom, and $E(t)$ is the external electric field.

Furthermore,

$$L(\hat{\rho}) = -\frac{\omega_r}{2Q}(N_{th} + 1)(b^\dagger b\hat{\rho} + \hat{\rho}b^\dagger b - 2b\hat{\rho}b^\dagger) - \frac{\omega_r}{2Q}N_{th}(bb^\dagger\hat{\rho} + \hat{\rho}bb^\dagger - 2b^\dagger\rho b), \tag{3}$$

where N_{th} is the thermal phonon occupation, and Q is the quality factor of the resonator.