Quantum Optics, Homework 3

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Stochastic wave function of a Λ system Figure 1 is a three-level Λ system. (a) Write down the effective Hamiltonian and quantum jump operators for Figure 1. (b) Suppose $|\psi_{\rm s}(t=0)\rangle = |g\rangle$. Describe how the wave function evolves using pseudocode. (c) Consider a case in which there is no quantum jump in $0 < t < t_0$. Find the time evolution of the wave function and the scattering rate

$$\gamma_1 = \langle\psi_{\rm s}|C_1^\dagger C_1|\psi_{\rm s}\rangle\,, \quad \gamma_2 = \langle\psi_{\rm s}|C_2^\dagger C_2|\psi_{\rm s}\rangle\,. \tag{1}$$

Solution

(a) The effective Hamiltonian is

$$H_{\rm eff} = \frac{\hbar}{2}\mathbf{\Omega}\cdot\boldsymbol{\sigma} - \frac{\mathrm{i}\hbar}{2}(C_1^\dagger C_1 + C_2^\dagger C_2), \tag{2}$$

where the quantum jump operators are

$$C_1 = \sqrt{\Gamma_1}\,|\mathrm{a}\rangle\langle\mathrm{e}|\,, \quad C_2 = \sqrt{\Gamma_2}\,|\mathrm{g}\rangle\langle\mathrm{e}|\,. \tag{3}$$

(b)

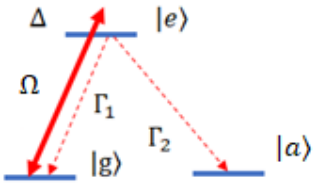

Figure 1: A three-level Λ system