Entanglement Dynamics of a Ladder-type Atom and Its Spontaneous Emission Fields

Vahideh Tahmoorian Askari Boroojerdi[1,2,a)]

[1]*Research Institute for Applied Physics and Astronomy, University of Tabriz, Tabriz, Iran*

[2] *University of Applied Science and Technology*

[a)]*v.tahmoorian@tabrizu.ac.ir*

Abstract. We discussed the creation of entanglement between a three level atom in a Ladder type configuration and its spontaneous emission. The entanglement is affected by parameters such as coherent driving fields' intensities, their relative phase and incoherent pumping field's rate. We also discussed the entanglement evolution due to the spontaneously generated coherence (SGC).

I-INTRODUCTION

One of the most dedicated properties of quantum mechanics which differentiates it from classical physics is entanglement. In quantum entanglement, there are states of composite systems (pair of particles say) that cannot be "factorized" into separate states for the component subsystems so that any measurement on one subsystem may effect on the other, this has made entanglement as a potential tool in a variety of new technologies [1-3].

III. EQUATIONS, RESULTS AND DISCUSSION

We consider a Ladder type atomic system as it is shown in figure.1, and numerically calculate the entanglement of this system and its spontaneous emission fields via quantum entropy measurement.

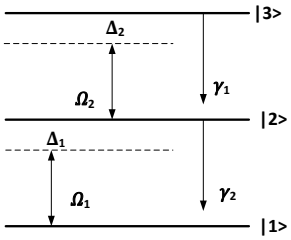
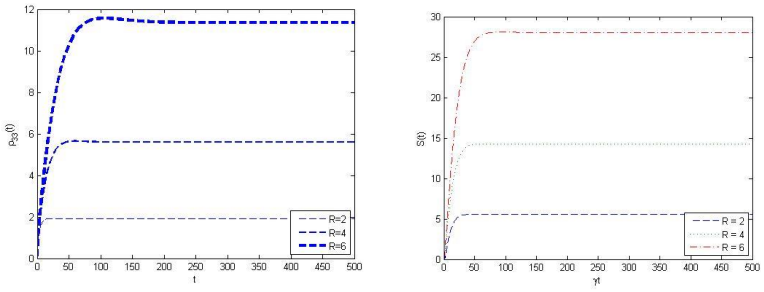


FIGURE.1 The equispace ladder configuration of atomic system and the employed fields

The basic density equations of motion for spontaneous emission which is obtained from the general master equation of a multilevel atom in an arbitrary configuration of the energy levels takes the following form for a Ladder configuration,

$$\dot{\rho}_{11} = 2\gamma_2\rho_{22}, \qquad \dot{\rho}_{22} = 2\gamma_1\rho_{33} - 2\gamma_2\rho_{22},$$
$$\dot{\rho}_{12} = 2\gamma_{12}\rho_{23}e^{-i(\omega_1-\omega_2)t} - \gamma_2\rho_{12}, \qquad \dot{\rho}_{23} = -(\gamma_1+\gamma_2)\rho_{23},$$
$$\dot{\rho}_{13} = -\gamma_1\rho_{13} \qquad \dot{\rho}_{33} = -2\gamma_1\rho_{33},$$

We can enhance the entanglement just by increasing the rate of incoherent field, R , it is displayed in figure2(a), to understand the reason of this, we calculated the population dynamics of level $|3\rangle$ in figure2(b). It is clear that the increase in level $|3\rangle$ population will result in larger fixed value of entanglement, it is understood by comparing figure 2(a) and figure 2(b).



(a) (b)

FIGURE.2 The system is initially in the ground state and under influence of coherent fields with $\Omega_2 = 4, \Omega_1 = 2$ and different incoherent pump field rates (a) Evolution of entanglement (b) Evolution of the population of level $|3\rangle$

REFERENCES

1. A. AC´IN, J. Ignacio Cirac and M. Lewenstein, *nature physics* APRIL 2007 VOL 3
2. N. Sangouard, *Review of Modern Physics*, Jan-March2011, Vol. 83

3. Bennett, C. H., G. Brassard, S. Popescu, B. Schumacher, J.A.Smolin, and W. K. Wootters, 1996, *Phys. Rev. Lett.* 76, 722.