Quantum State Transfer in Atom-Cavity Systems with Uncolored Cayley Interacting Networks

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Abstract Considering the two-photon exchange interaction between \( n \) coupled cavities each of them containing a two level atom, the atomic and photonic state transfer is investigated. In fact, \( n \) atom-cavity systems are considered to be distributed on the nodes of an uncolored Cayley network and interact with each other via the adjacency matrix of the corresponding network. Then, by employing the photon-excitation conservation and also the algebraic structure of the networks, such as irreducible characters of the groups associated with the networks, some suitable basis for the atom-cavity state space is introduced based on the corresponding generalized Fourier transform, so that the Hamiltonian of the whole system, is block diagonalized with two-dimensional blocks. Then, by solving the corresponding Schrödinger equation exactly, quantum state transfer and also entanglement generation between the atoms or the photons are discussed. For instance, the probability amplitudes associated with the photon transition between the cavities or excitation transition between the atoms are obtained in terms of the irreducibles characters of the corresponding network and the hopping parameter \( \xi \) between the cavities.

Keywords Coupled cavities · Two-photon exchange · Hopping strength · Two-level atoms · Generation of entanglement · Excitation and photon transfer · Uncolored Cayley graphs · Generalized fourier transform

1 Introduction

In the past years, several schemes for quantum information transition and the generation and distribution of entanglement have been designed and implemented in a number of physical systems (see for example [1]-[21]). Atoms and ions are particularly considered as tools

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