量子光学

A simple scheme for realizing four-photon GHZ state based on cavity quantum electrodynamics

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摘要：

提出一种利用阶梯型三能级原子与两个双模腔谐振相互作用制备四光子GHZ态的方案。在该方案中，量子信息编码在腔场的虎克态中。通过求解薛定谔方程，得到相互作用系统的量子态。原子通过两个腔后被测量时，场能崩塌到所需要的GHZ态。结果表明该方案简单且实验上可行。

关键词： 量子光学　GHZ态　阶梯型三能级原子　双模腔

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Abstract:

A scheme is presented for generating four-photon Greenberger-Horne-Zeilinger (GHZ) states with resonant interaction between a cascade type three-level atom and two bimodal cavities. In the proposed protocol, the quantum information is encoded on Fock states of the cavity fields. Schrödinger equation of the system is solved and quantum states of interaction system are obtained. The detection of atom can collapse cavity to the desired GHZ state. It is shown that the scheme is simple and the experimental implementation is feasible.

Keywords: quantum optics　GHZ state　cascade three-level atom　bimodal cavity

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参考文献：

[1] Raimond J M, Brune M, et al.Manipulating quantum entanglement with atoms and photons in a cavity [J]. Rev. Mod. Phys. 2001,73:565~582.
[2] Tang Shiqing, Zhang Dengyu, et al. Realization of three-qubit controlled-phase gate operation with atoms in cavity QED system [J]. Chin. Phys. Lett. 2009,26: 020310.
[3]Wang Cheng-zhi, Fang Mao-fa. Quantum entanglement in a two-dimensional ion trap [J]. Chinese Physics, 2003,(12)3:287~293.
[4]Song Ke-hui, Guo Guang-can. Realization of a spin type GHZ state via the Jaynes Cummings model with large detuning[J]. Acta Optica Sinica , 1999,48(4):661~666.(in Chinese)
[5]Xiang Sao-hua. Temperture effects on thermal entanglement in multi-photon Jaynes-Cummings model [J]. Journel of Huaihua University, 2004,23(5):22~25.

[6] Zhang Dengyu, Xie Lijun, Tang Shiqing, et al. Time evolution of two coupling two-level atoms entanglement in a single-mode vacuum field[J]. Chinese Journal of quantum Electronics(量子电子学报), 2009,26(1):65~68

[7] Tang Shiqing, Zhang Dengyu, Gao Feng, et al. Scheme for implementing a three-qubit Toffoli gate resonant interaction in bimode cavity QED system[J]. Chinese Journal of quantum Electronics(量子电子学报), 2009,26(5):548~554

[8] Zhan Xiaogui, Zhang Dengyu, Gao Feng, et al. Controlled teleportation of an arbitrary two-qubit superposition state[J]. Chinese Journal of quantum Electronics(量子电子学报), 2009,26(1):44~49 (in Chinese)

[9]Rauschenbeutel A, Bertet P, Osnaghi S, et. al. Controlled entanglement of two field modes in a cavity quantum electrodynamics experiment [J]. Phys. Rev. A, 2001,64:050301 (R) (1~4).

[10] Rauschenbeutel A, Nogues G, Osnaghi S, et al. Step-by-step engineered multiparticle entanglement [J]. Science, 2000,288:2024~2028.

[11] Zhang yongde, Principle of Quantum Information Physics (Beijing: Science Press) [M].2005.

[12] Wang Xinwen, Shan Yongguang, Xia Lixin and Lu Maowang. Dense coding and teleportation with one-dimensional cluster states [J]. Phys. Lett. A, 2007, 364(1): 7~11.

[13] Dür W, Vidal G. and Cirac J I. Three qubits can be entangled in two inequivalent ways[J]. Phys. Rev. A, 2000,62(6), 062314 (1~12).

[14] Khrennikov A Contextual Approach to Quantum Fomalism (Berlin:Springer) [M]. 2009.

[15] Meng Fanyu, Zhu Aidong, Yeon Kyu-Hwang and Yu Seong-Cho.Preparation of multipartite entangled states and one-step implementation of 1→M economical phase-covariant quantum anti-cloning in cavity QED[J]. Phys. Scr., 2010, 81(1): 015009(1~5).

[16] Zheng Shibiao.One-step synthesis of multiation Greenberger-Home-Zeilinger states [J]. Phys. Rev. Lett. ,2001,87(23):230404.

[17] Wu Chunfeng, Chen Jingling, Kwek L C and Oh C. H. Quantum nonlocality of N-qubit W states[J]. Phys. Rev. A, 2006, 73(1): 012310 (1~5). [18] Zhong Zhirong. Generation of four-photon W state via cavity QED[J]. Chinese Phisics B, 2008,17(9):3217~3219.

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