量子光学

基于分离腔系统远程制备W态方案

丁智勇[1],何娟[2],吴韬[2]

阜阳师范学院物理与电子科学学院，安徽 阜阳 236029

摘要：　提出了一个在分别由两光纤连接的三个分离腔中远程制备三原子W态的方案。制备过程中，由于原子系统、腔模和光纤模均处于非激发态，因此该方案能有效地抑制原子的自发辐射、腔衰减以及光纤泄露。相比与其他方案，我们方案的优点是所用的绝热演化方法对实验参数的变化不敏感。另外，该方案可以简单推广到制备n个原子的W态。

关键词：　W态　远程原子　分离腔

Implementing W state of remote atoms trapped in separated cavities

School of Physics and Electronic Science, Fuyang Normal College, Fuyang 236029, China

Abstract: A scheme was proposed for implementing the entangled W state of three atoms trapped in distant cavities connected by single-mode fibers. The scheme is robust to atomic spontaneous decay, cavity decay and photon leaking out of the fiber due to that the atomic system, all the modes of cavity fields and fibers are only virtually excited. Compared to the previous schemes, the significant advantage is that the adiabatic passage is applied in our scheme. It does not need precise control of the Rabi frequency, pulse duration and is insensitive to moderate fluctuations of experimental parameters. In principle, the n-atom W state can be prepared by using such a method.

Keywords: W state　remote atoms　separated cavities

通讯作者：丁智勇（1980－）安徽无为人，硕士，讲师，主要研究领域为量子物理。

作者简介：

作者Email: dzy_8012@163.com

参考文献：

[1] Einstein A, Podolsky B, and N. Rosen, Can quantum-mechanical description of physical reality be considered complete? [J].Phys. Rev. 1935, 47:777-780.
[2] Greenberger D M, Horne M A, and Zeilinger A, In "Bell's Theorem, Quantum Theory, and Conceptions of the Universe", edited by M Kafatos (Kluwer, Dordrecht 1989).
[3] Bell J S, On the Eienstein-Podolsky-Rosen Paradox [J]. physics, 1964, 1: 195.
[4] Bennett C H, Brassard G, Crepeau C, Jozsa R, Peres A, and Wootters W K, Teleporting an unknown quantum state via dual classical and Einstein-Podolsky-Rosen channels [J]. Phys. Rev. Lett., 1993, 70:1895.
[5] Cleve R, Gottesman D and Lo H-K. How to Share a Quantum Secret [J]. Phys. Rev. Lett., 1999, 83: 648.

[6] Cirac J I, Ekert A K, Huelga S F and Macchiavello C, Distributed quantum computation over noisy channels [J]. Phys. Rev. A, 1999, 59: 4249.

[7] Greenberger M, Horne M A, Shimony A, and Zeilinger A, Bell's theorem without inequalities [J]. Am. J. Phys., 1990, 58: 1131.

[8] Dür W, Vidal G, and Cirac J I, Three qubits can be entangled in two inequivalent ways [J]. Phys. Rev. A, 2000, 62: 062314.

[9] Chen L B, Ye M, Lin G W, Du Q H , Lin X M , Generation of entanglement via adiabatic passage [J]. Phys. Rev. A, 2007, 76 : 062304.

[10] Mancini S, Bose S, Engineering an interaction and entanglement between distant atoms [J]. Phys. Rev. A, 2004,70: 022307.

[11] Serafini A, Mancini S, Bose S, Distributed Quantum Computation via Optical Fibers [J]. Phys. Rev. Lett., 2006, 96: 010503.

[12] Peng P, Li F L, Entangling two atoms in spatially separated cavities through both photon emission and absorption processes [J]. Phys. Rev. A, 2007, 75: 062320.

[13] Ye S Y, Zhong Z R, Zheng S B, Deterministic generation of three-dimensional entanglement for two atoms separately trapped in two optical cavities [J].Phys. Rev. A, 2008, 77: 014303.

[14] Zheng S B, Generation of Greenberger-Horne-Zeilinger states for multiple atoms trapped in separated cavities [J]. Eur. Phys. J. D 2009, 54: 719-722.

[15] Lü X Y, Si L G, Hao X Y, Yang X X, Achieving multipartite entanglement of distant atoms through selective photon emission and absorption processes[J]. Phys. Rev. A, 2009, 79 : 052330.

[16] Ye L, Xiong W, Li A X, Guo G C, Implementing ancilla-free phase covariant quantum cloning with atoms trapped in cavities [J]. Sci China Phys Mech Astron, 2011, 54: 262-267.

[17] Lü X Y, Liu J B, Ding C L, et al, Dispersive atom-field interaction scheme for three-dimensional entanglement between two spatially separated atoms [J]. Phys. Rev. A, 2008, 78: 032305.

[18] Wu Y, Saldana J, Zhu Y, Large enhancement of four-wave mixing by suppression of photon absorption from electromagnetically induced transparency [J]. Phys. Rev. A, 2003, 67: 013811.

[19] Zheng S B , Guo G C, Efficient Scheme for Two-Atom Entanglement and Quantum Information Processing in Cavity QED [J]. Phys. Rev. Lett., 2000, 85: 2392-2395.

[20] Duan L M, Kuzmich A, Kimble H J, Cavity QED and quantum-information processing with "hot" trapped atoms [J].Phys. Rev. A, 2003, 67: 032305.

[21] Savukov I M, Berry H G, Laser gas-discharge absorption measurements of the ratio of two transition rates in neutral argon [J]. Phys. Rev. A, 2003, 67 : 032505.

[22] Trupke M, Goldwin J, DarquiéB, et al, Atom detection and photon production in a scalable, open, optical microcavity [J]. Phys. Rev. Lett., 2007, 99: 063601.

[23] Blatt R, Wineland D, Entangled states of trapped atomic ions [J].Nature, 2008, 453:1008-1015.

[24] Osnaghi S., Bertet P, Auffeves A, et al, Coherent control of an atomic collision in a cavity [J]. Phys. Rev. Lett., 2001, 87: 037902.

本刊中的类似文章

1．韩峰 满忠晓 夏云杰.Tavis-Cummings模型下利用W态与GHZ态远程控制原子的布居差演化[J]. 量子电子学报, 2010,27(1): 69-76

2．马刚龙 查新未.四粒子W态的概率隐形传态[J]. 量子电子学报, 2010,27(3): 308-313

3．钟锋,于立志,熊文元.囚禁离子多体纠缠态的简单制备方案[J]. 量子电子学报, 2011,28(4): 420-428

4．王栋 叶柳.基于最大和非最大纠缠信道一类三量子比特W态的远程制备方案[J]. 量子电子学报, 2012,29(3): 330-338

5．水田 查新未 王东 李宁.一种较好的三粒子W态概率隐态传输方案[J]. 量子电子学报, 2012,29(3): 339-343