量子光学

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

王栋, **叶柳**

安徽大学物理与材料科学学院, 安徽 合肥 230039

摘要：

基于最大纠缠信道和非最大纠缠信道，提出了两个一类三量子比特W态的远程制备方案。在制备过程中，需要实施三量子比特的投影测量和一些幺正操作。方案的成功几率和经典信息量消耗被计算。结果显示，两个方案都能以一定几率高保真度地实现。此外，讨论了方案的特性以及进行了可行性分析。发现，当被制备态属于一些特殊态时成功几率被大大提高；方案也是切合目前的实验技术，具有可行性。

关键词： 量子光学　远程态制备　纠缠　W态　经典信息消耗

Schemes for remotely preparing a class of three-qubit W states based on bipartite maximally and non-maximally entangled quantum channels

WANG Dong，YE Liu

School of Physics & Material Science, Anhui University, Hefei 230039, China

Abstract:

Two schemes are put forward to remotely implement the preparation of a class of three-qubit W states, which employ maximally entangled states and non-maximally entangled states as the quantum channels, respectively. In the course of the preparations, some local quantum operations including three-qubit projective measurements and unitary transformations are required. We canonically work out the success probability and classical information cost. The result shows that both schemes can be faithfully achieved in a probabilistic manner. Furthermore, we have some discussions on the properties of the presented schemes and evaluate their experimental feasibility. It is found that, the success probability can be doubled if the prepared states belong to some special ensembles, and our schemes can be well implemented with the current technologies.

Keywords: quantum optics　remote state preparation　entanglement　W state　classical information cost

通讯作者: 王栋（1981-），安徽潜山人，博士，讲师，主要研究方向为量子信息与量子计算。

作者简介:

作者Email: dwang@ahu.edu.cn

参考文献：

[1] Ekert A, Quantum cryptography based on Bell's theorem [J]. Phys. Rev. Lett., 1991, 67(6): 661-663.

[2] Bennett C H, Brassard G, Crepeau C, et al., Teleporting an unknown quantum state via dual classical and Einstein-Podolsky-Rosen channels [J]. Phys. Rev. Lett., 1993, 70(13): 1895-1899.

[3] Buzek V, Hillery M, Quantum copying: Beyond the no-cloning theorem [J]. Phys. Rev. A, 1996, 54(3): 1844-1852.

[4] Zhang W H, Dai J L, Cao Z L, Yang M, A class of optimal phase-covariant quantum cloning [J]. Chinese Journal of Quantum Electronics, 2011, 28(5): 583-687.

[5] Hillery M, Buzek V, Berthiaume A, Quantum secret sharing [J]. Phys. Rev. A, 1999, 59(3): 1829-1834.

[6] Lo H K, Classical-communication cost in distributed quantum-information processing: A

generalization of quantum communication complexity [J]. Phys. Rev. A, 2000, 62(1): 012313.

[7] Bennett C H, DiVincenzo D P, Shor P W, et al., Remote state preparation [J]. Phys. Rev. Lett., 2001, 87(7): 077902.

[8] Pati A K, Minimum classical bit for remote preparation and measurement of a qubit [J]. Phys. Rev. A, 2000, 63(1): 014302.

[9] Devetak I, Berger T, Low-entanglement remote state preparation [J]. Phys. Rev. Lett., 2001, 87(19): 197901.

[10] Berry D W, Sanders B C, Optimal remote state preparation [J]. Phys. Rev. Lett., 2003, 90(5): 057901.

[11] Leung D W, Shor P W, Oblivious remote state preparation [J]. Phys. Rev. Lett., 2003, 90(12): 127905.

[12] Kurucz Z, Adam P, Janszky J, General criterion for oblivious remote state preparation [J]. Phys. Rev. A, 2006, 73(5): 062301.

[13] Hayashi A, Hashimoto T, Horibe M, Remote state preparation without oblivious conditions [J]. Phys. Rev. A, 2003, 67(5): 052302.

[14] Abeyesinghe A, Hayden P, Generalized remote state preparation: Trading cbits, qubits, and ebits in quantum communication [J]. Phys. Rev. A, 2003, 68(6): 062319.

[15] Ye M Y, Zhang Y S, Guo G C, Faithful remote state preparation using ?nite classical bits and a non-maximally entangled state [J]. Phys. Rev. A, 2004, 69(2): 022310.

[16] Liu J M, Feng X L, Oh C H, Remote preparation of a three-particle state via positive operator-valued measurement [J]. J. Phys. B, 2009, 42: 055508.

[17] Wang D, et al., Remote preparation of a class of three-qubit states [J]. Opt. Commun., 2008, 281(4): 871-875.

[18] Nguyen B A, Kim J, Joint remote state preparation [J]. J. Phys. B, 2008, 41: 095501.

[19] Nguyen B A, Joint remote state preparation via W and W-type states [J]. Opt. Commun., 2010, 283(20): 4113-4117.

[20] Zhan Y B, Hu B L, Ma P C, Joint remote preparation of four-qubit cluster-type states [J]. J. Phys. B, 2011, 44: 095501.

[21] Kurucz Z, Adam P, Kis Z, Janszky J, Continuous variable remote state preparation [J]. Phys. Rev. A, 2005, 72: 052315.

[22] Xiang G Y, Li J, Bo Y, Guo G C, Remote preparation of mixed states via noisy entanglement [J]. Phys. Rev. A, 2005, 72: 012315.

[23] Liu W T, Wu W, Ou B Q, et al., Experimental remote preparation of arbitrary photon polarization states [J]. Phys. Rev. A, 2007, 76: 022308.

[24] Wu W, Liu W T, Chen P X, et al., Deterministic remote preparation of pure and mixed polarization states [J]. Phys. Rev. A, 2010, 81: 042301.

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

[26] Roos C F, Riebe M, Haffner H, et al., Control and Measurement of Three-Qubit Entangled States [J]. Science, 2004, 304: 1478-1480.

[27] Aharonov Y, Albert D Z, Vaidman L, How the result of a measurement of a component of the spin of a spin-1/2 particle can turn out to be 100 [J]. Phys. Rev. Lett., 1988, 60(14): 1351-1354.

[28] Tian L, Lloyd S, Orlando T P, Projective measurement scheme for solid-state qubits [J]. Phys. Rev. B, 2003, 67(22): 220505(R).

[29] Plantenberg J H, De Groot P C, Harmans C J P M, et al., Demonstration of controlled-NOT quantum gates on a pair of superconducting quantum bits [J]. Nature, 2007, 447: 836-839.

本刊中的类似文章

(4): 477-481

12．胡桂玉 杨振 叶柳.在离子阱中实现量子SWAP门的方案[J]. 量子电子学报, 2009,26(5): 555-559

13．吴张斌 陈光 杨伯君.基于BBM92协议的量子密钥分发系统改进方案[J]. 量子电子学报, 2009,26(5): 560-564

14．熊狂炜 艾剑锋.利用非最大纠缠态实现未知原子态的受控传递[J]. 量子电子学报, 2009,26(5): 565-569

15．陶蕊 郑小虎 曹卓良.用约瑟夫森结量子比特制备簇态[J]. 量子电子学报, 2009,26(5): 570-576