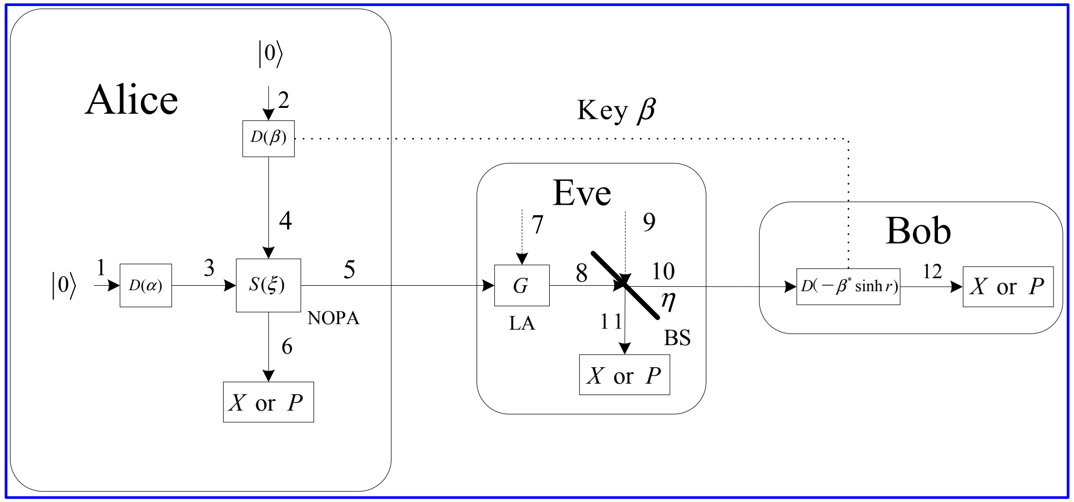
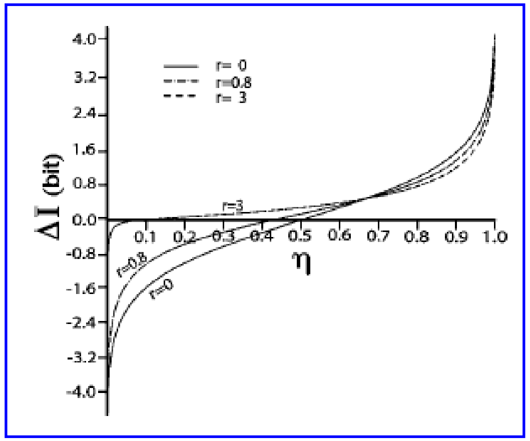
理论研究

（一）基于连续变量纠缠对的量子安全通信系统





密钥分发过程

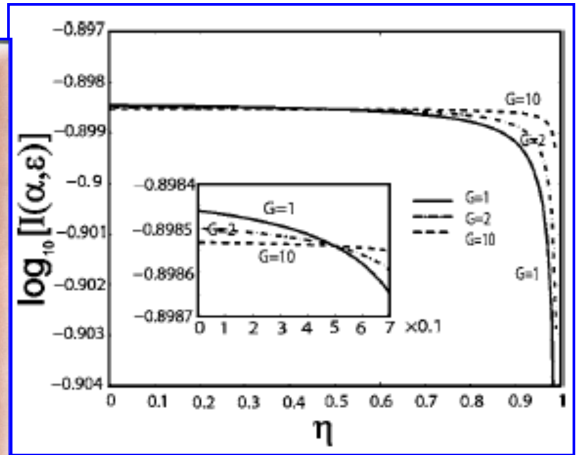
该工作首次把量子密钥分发和量子加密有机统一，可有效抵抗高斯克隆攻击。被包括量子光学权威M. S. Zubairy在内的国内外同行引用20余次，受到了广泛关注，并获得第十二届全国量子光学大会优秀论文奖。


荣誉证书

何广强：

荣获2006年全国量子光学大会研究生优秀论文奖

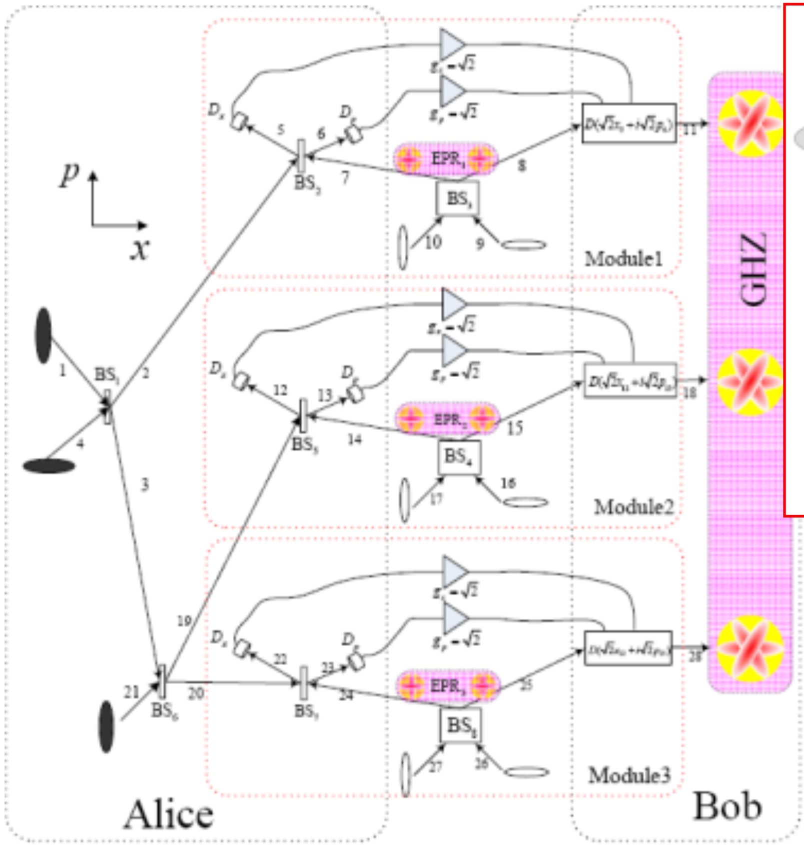
三 等 奖

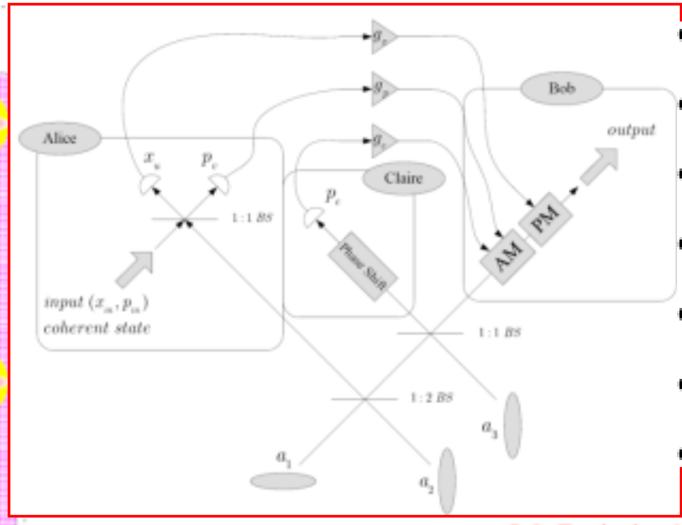


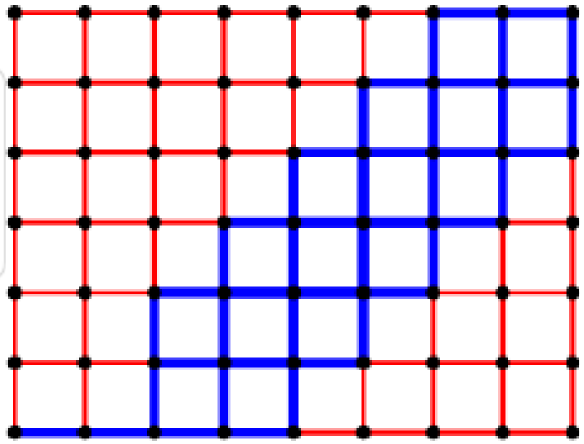
量子加密过程

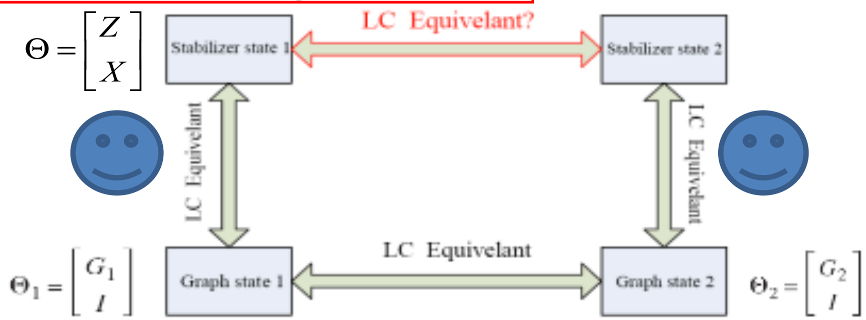
1. Guangqiang He, Jingtao Zhang, Jun Zhu and Guihua Zeng, Physical Review A, 84, 034305 (2011)
2. Guangqiang He, Jun Zhu and Guihua Zeng, Physical Review A, 73, 012314 (2006).

（二）连续变量量子通信网络研究









1. Guangqiang He, Jing Tao Zhang and Guihua Zeng, Journal of Physics B, 41, 215503 (2008)

2. Jingtao Zhang, Guangqiang He and Guihua Zeng, Physcial Review A, 80, 052333 (2009).

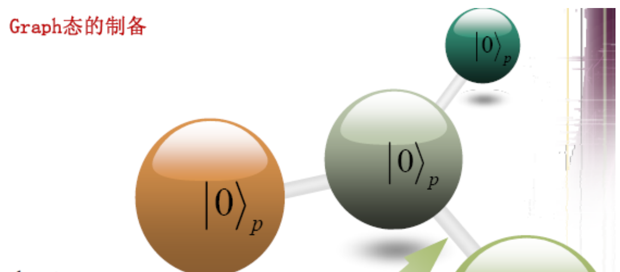
3. Lijie Ren, Guangqiang He and Guihua Zeng, Physical Review A, 78, 042302 (2008)

4. Ding Nie, Guangqiang He and Guihua Zeng, Journal of Physics B, 41,175504 (2008)

5. Y. Gu, X. F. Wu and G. Q. He, Physical Rev. A, 85, 052328 (2012)

（三） 基于Graph态量子通信网络

Graph态的制备

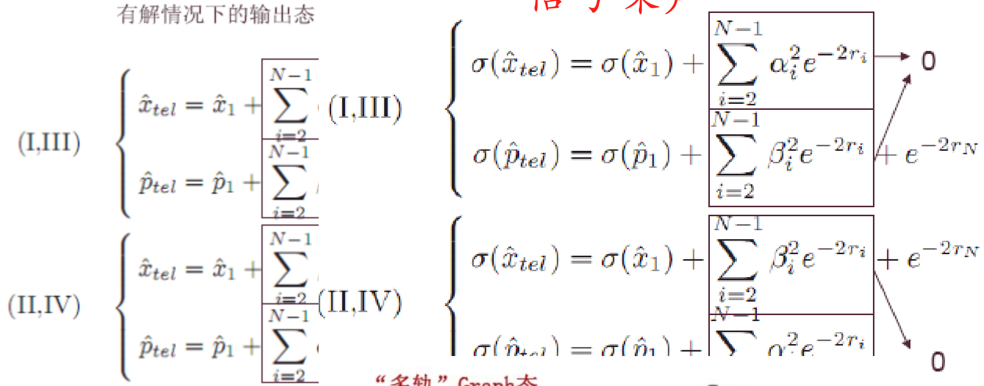


$$\begin{cases}\hat{x}_i^g = \hat{x}_i \\ \hat{p}_i^g = \hat{p}_i + \sum_{j=1}^{N} g_{ij}\hat{x}_j\end{cases}$$

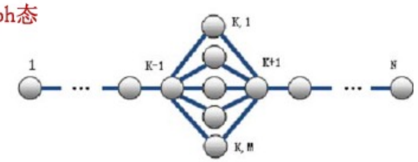
数学模型

有解情况下的输出态

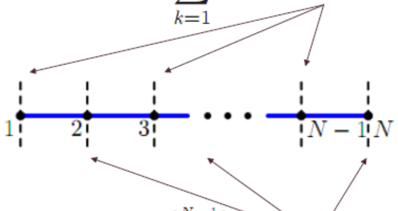
信号噪声



“多轨” Graph态

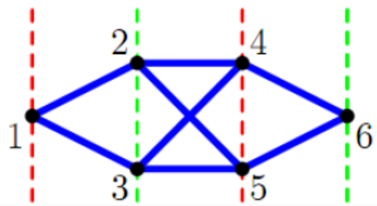


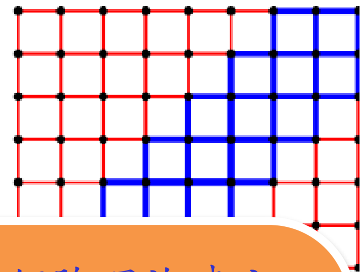
线性Graph态



$$\hat{x}_{tel} = \hat{x}_1 + \sum_{k=1}^{[\frac{N}{2}]}(-1)^{k+1}\hat{p}_{2k}$$

$$\hat{p}_{tel} = \hat{p}_1 + \sum^{[\frac{N-1}{2}]}(-1)^{k}\hat{p}_{2k+1}$$

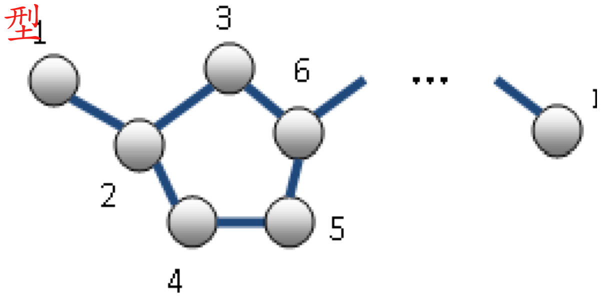




数学模型

$$\prod T(s_k)$$

$$\Updownarrow$$



$$\text{(I)}\begin{cases}\hat{x}_{tel} = u + \hat{x}_N^g \\ \hat{p}_{tel} = v + \hat{p}_N^g\end{cases} \quad \text{(II)}\begin{cases}\hat{x}_{tel} = v + \hat{p}_N^g \\ \hat{p}_{tel} = u - \hat{x}_N^g\end{cases} \quad u = \sum_{i=1}^{N-1}\alpha_i p$$

$$\text{(III)}\begin{cases}\hat{x}_{tel} = u - \hat{x}_N^g \\ \hat{p}_{tel} = v - \hat{p}_N^g\end{cases} \quad \text{(IV)}\begin{cases}\hat{x}_{tel} = v - \hat{p}_N^g \\ \hat{p}_{tel} = u + \hat{x}_N^g\end{cases} \quad v = \sum_{i=1}^{N-1}\beta_i p$$

基于连续量子Graph纠缠态，采用矩阵理论建立了一种通用的量子通信网络数学模型，推导出进行量子网络通信的充分条件，可定量研究最优量子路由问题。推导出量子信号以及量子信号噪声解析表达式。并采用Matlab语言设计了相应程序快速分析各种量子网络的性能。

（四）基于连续变量Graph态的量子密码网络协议

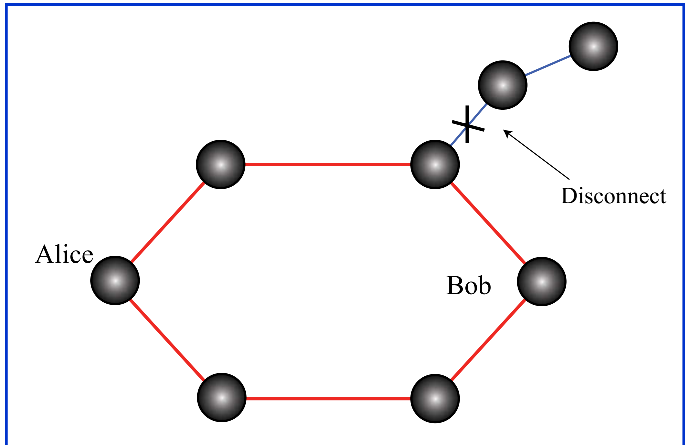


FIG. 1. (Color online) An example of "polish."

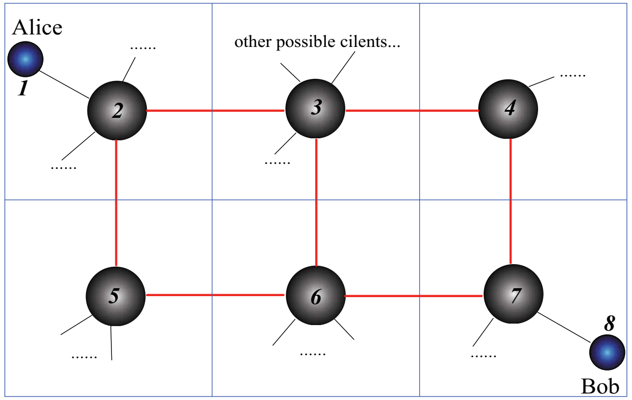


FIG. 2. (Color online) Cellular cryptography network.

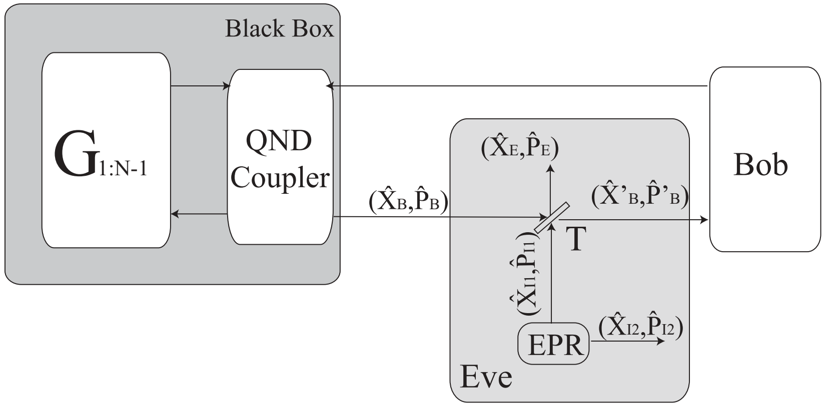
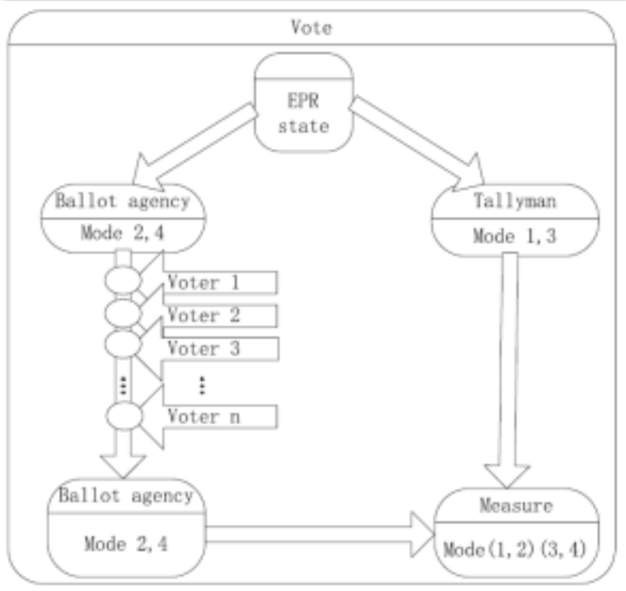


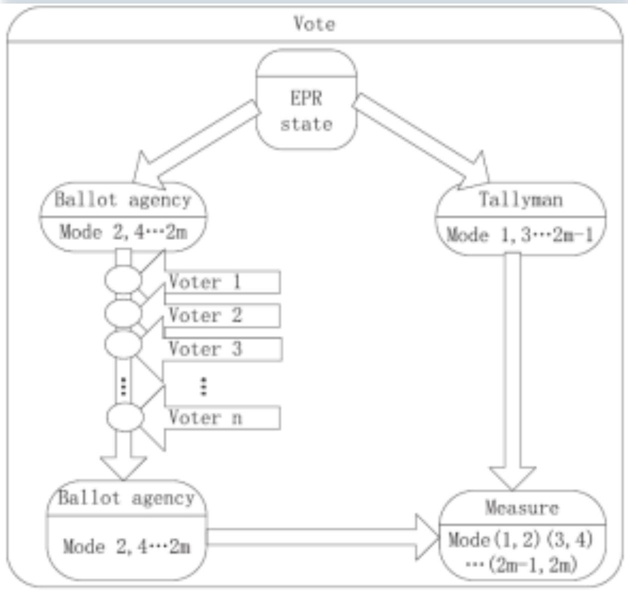
FIG. 3. Equivalent system diagram in the presence of Eve.

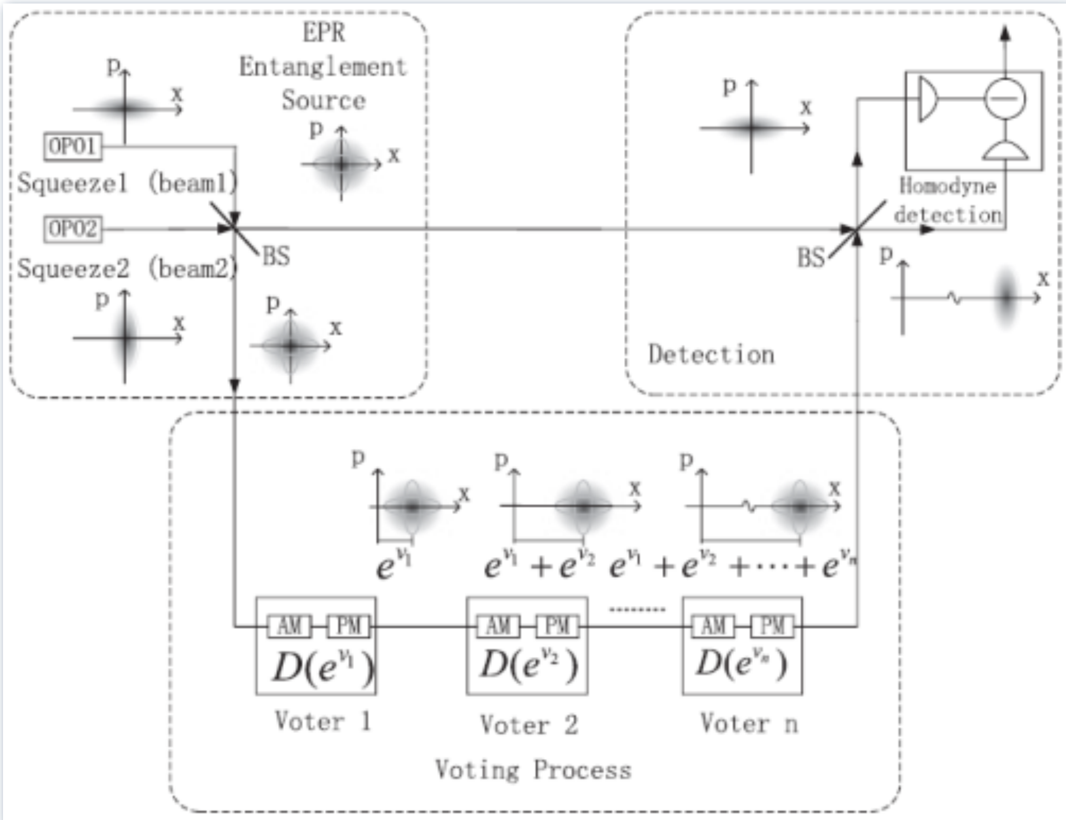
Y. J. Qiang, G. Q. He et al, Quantum-cryptography network via continuous-variable graph states, Phys. Rev. A, 86, 052333 (2012)


俄
苏
联
斯
罗
图 例
Legend
Capital city
Seat of Sheng-level administration area
Seat of Fu-level administration area
Other inhabited locality
International boundary
Provincial boundary
Regional boundary
Contemporary national capital
Seat of contemporary province-level administration area
Seat of a contemporary city
Other contemporary inhabited locality
南海

（五）连续变量量子匿名投票

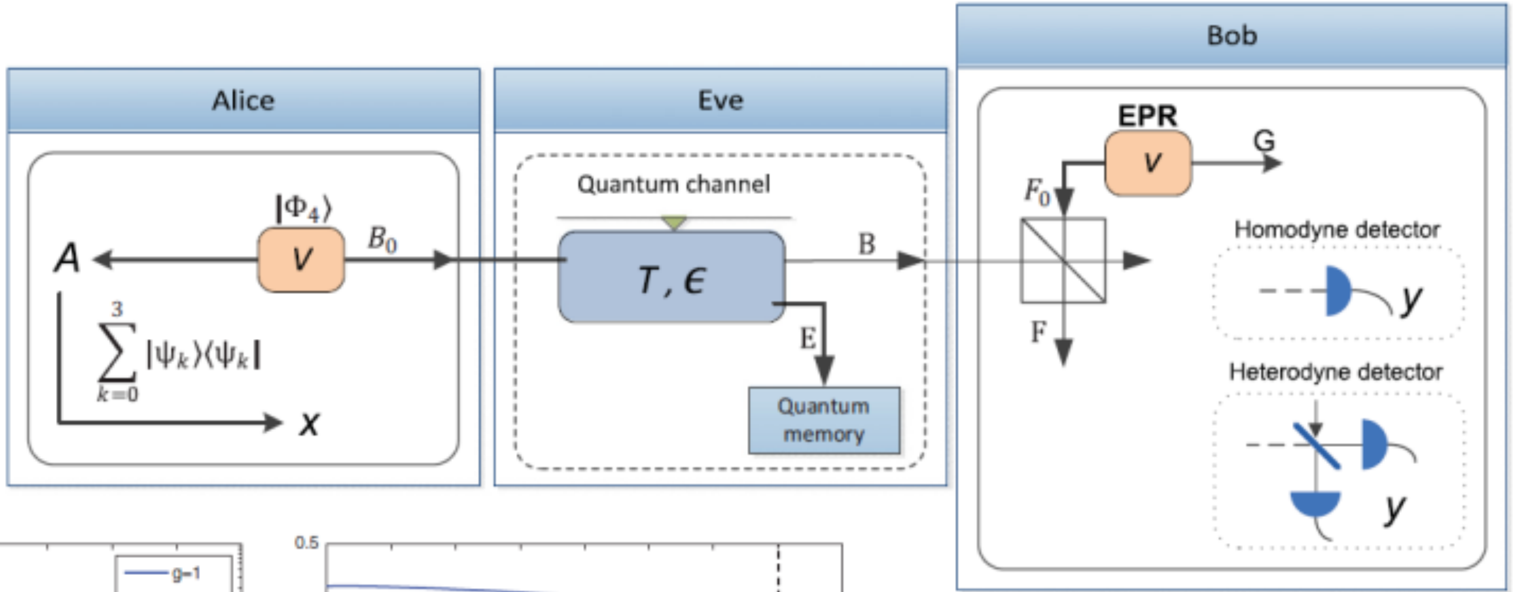






1. L. Jiang, G. Q. He, D. Nie, J. Xiong and G. H. Zeng, Physical Review A, 85, 042309 (2012)

（六）采用PSA和PIA提高CVQKD的性能



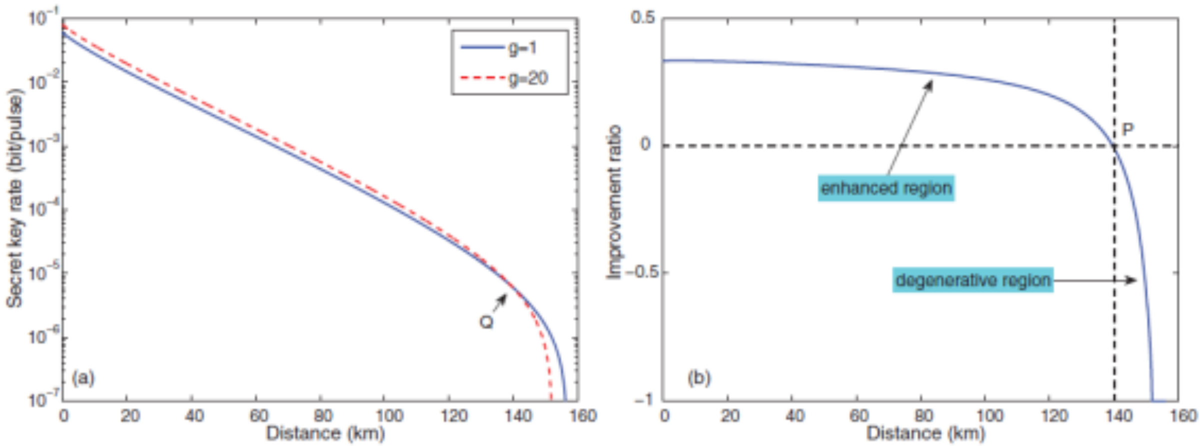


FIG. 6. (Color online) Heterodyne detection with an inserted PIA, $\epsilon = 0.005$, $V_A = 0.3$. (a) Secret key rate for $g = 1$ (full line), and $g = 20$ (dashed line). (b) Improvement ratio after inserting a PIA.

采用PSA和PIA提高CVQKD的性能，同时也可以采用非高斯操作提高CVQKD的性能。

H. Zhang, J. Fang and G. Q. He, PRA, 86, 022338 (2012)
P. Huang, G. Q. He, J. Fang and G. H. Zeng, PRA 87, 012317 (2013)