

半導体発光素子による光子数量子状態発生と量子光学

研究代表者 井元信之(阪大基礎工)

Non-classical light source for long-distance quantum cryptography

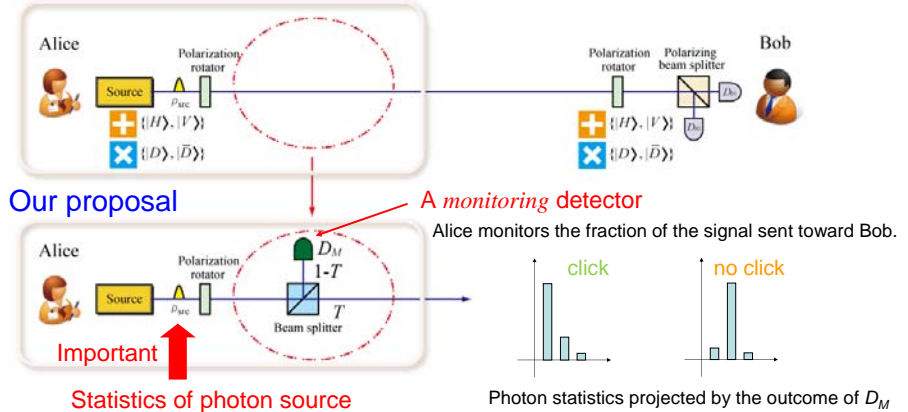
Non-classical light sources

- Semiconductor quantum dot
- Trapped atom
- Parametric down-conversion
- Color center in Diamond
- ...

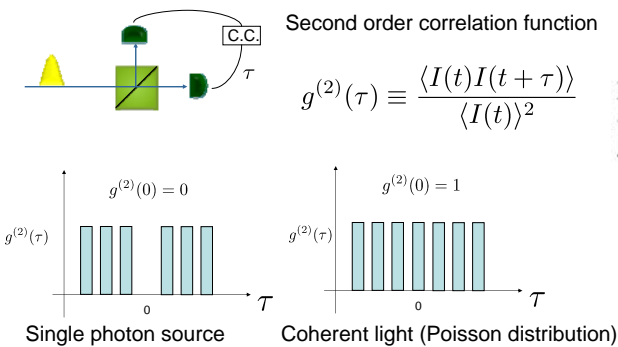
Various applications for quantum information processing

- Quantum computation
- Quantum cryptography
- ...

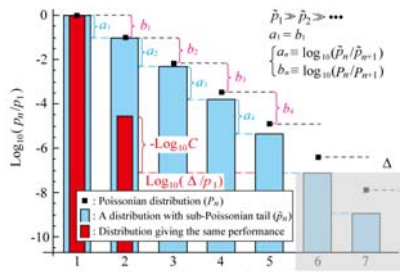
The conventional system based on a polarization encoding



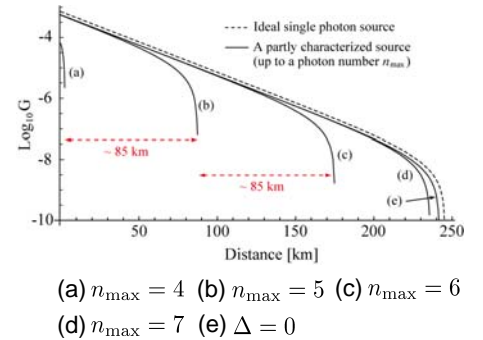
Characterization of single photon source by $g^{(2)}$



Our proposed characterization



Secure key generation rates ($g^{(2)} = 0.19$)



Yoritoshi Adachi, Takashi Yamamoto, Masato Koashi, Nobuyuki Imoto, New J. Phys. 11, 113033 (2009).

Optimal entanglement generation for hybrid quantum repeaters

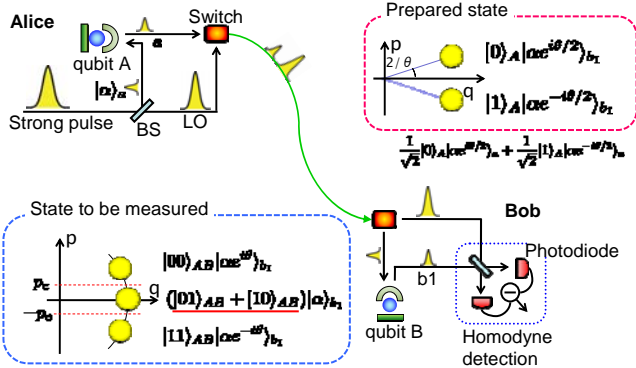
This leads to arbitrary long-distance quantum communication.

Entanglement generation between quantum memories in hybrid quantum repeater

Quantum dot in cavity, Trapped atom
Color center in Diamond, ...

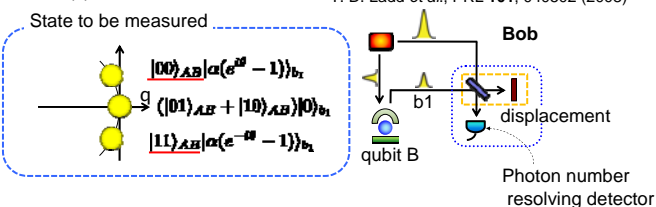
Protocol (i)

P. van Loock et al., PRL 96, 240501 (2006)
T. D. Ladd et al., New J. Phys. 8, 30 (2006)

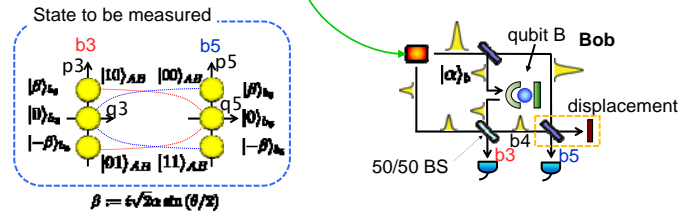


Protocol (ii)

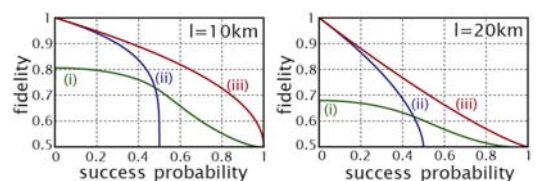
P. van Loock et al., PRA 78, 062319 (2008)
T. D. Ladd et al., PRL 101, 040502 (2008)



Our protocol (iii)



Performance under loss in the fiber (0.17 dB/km)



Features of our protocol

- (1) Our protocol boasts the best performance.
- (2) Generated entanglement includes only one type of error.
- (3) Our protocol can achieve the theoretical limit of performance over arbitrary single-error-type entanglement generation.

Koji Azuma, Naoya Sota, Ryo Namiki, Sahin Kaya Ozdemir, Takashi Yamamoto, Masato Koashi, Nobuyuki Imoto, to appear in PRA (R) (arXiv:0811.3100)