Quantum Computation using Photons

Non-postselected quantum teleportation
for entanglement manipulation of photons

Shigeki Takeuchi, Kenji Tsujino
Contact: takeuchi@es.hokudai.ac.jp
JST CREST and Research Institute for Electronic Science, Hokkaido University

1. Motivation

Among many candidates for quantum bits, photon is the only quanta whose quantum state can be transmitted over several ten kilometers. Development of the technology to manipulate entanglement of photons is important because it will also serve the input/output method to connect the quantum computers each other. There have been several approaches to invent devices for the entanglement manipulation such as quantum phase gate (Q.P.G.), however, any Q.P.G. for visible/near IR photons has not been realized. As an alternative approach, it is reported that quantum teleportation can also be used to generate entanglement between separated photons. However, the performed experiments of quantum teleportation using photons had problems, one of which is called `post-selection'. Toward the future realization of entanglement manipulation of multi photons, now we are trying to perform `non-postselected' quantum teleportation using photons as the first stage.

2. Concept of our experiment

The basic scheme of quantum teleportation is shown in Figure 1. When the two EPR-Sources emit photon pairs simultaneously, the polarization of photon B is `teleported' to the photon D. In the previous experiment, however, the case one of the source emitted two pairs almost simultaneously causes misjudgments because the detectors could not identify the number of incident photons. Now we are trying to perform the improved experiment using multi-photon counters to eliminate this incompleteness.

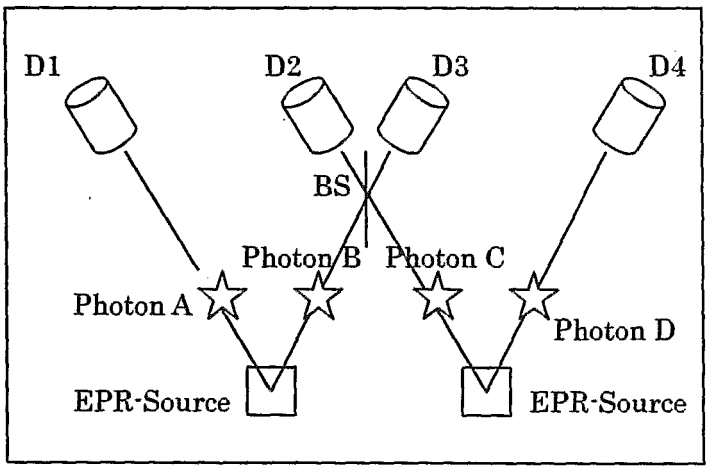

Figure 1: A scheme of Quantum Teleportation

(1) Publications

1) K.Hashi, T.Shimizu, A.Goto, H.Kitazawa, G.Kido, T.Suzuki, "Experimental aspects of an NMR computer with CeP" , Applied Physics A 70 (2000) 359-360

2)A. Goto, R. Miyabe, T. Shimizu, H. Kitazawa, K. Hashi, H. Abe, G. Kido, K. Shimamura and T. Fukuda, Investigation for possible crystal NMR quantum computing devices with lithium fluorides I: BaLiF3, Physica B (in press).]

3)G. Kido, H. Shinagawa, K. Terai, K. Hashi, A. Goto, T. Yakabe, T. Takamasu, S. Uji, T. Shimizu and H. Kitazawa, Progress of Solid-state MRFM quantum computers at NRIM, Physica B (in press).

(2) Presentations

1)東條悟、山階克久、北川勝浩 (大阪大学大学院基礎工学研究科物理系専攻電子光科学)
「ブロモトリフルオロブテンを用いた 3-qubit NMR 量子計算実験」日本物理学会　2000 年春の分科会
関西大学、　　2000 年 3 月 23 日

2) Duger Ulam-Orgikh and Masahiro Kitagawa, Spin squeezing and decoherence limit in Ramsey spectroscopy -- Even sub-optimal entanglement can achieve absolute improvement --, Fifth International Conference on Quantum Communication Measurement & Computing, (July 3-8, 2000, Capri).

3) T. Terao, Dihedral angle determination and optical nuclear polarization, XIX International Conference on Magnetic Resonance in Biological Systems (August 20-25, 2000, Florence), Book of Abstructs, p.98.

(3) Patent　　no application