Restoration of Entanglement by Spectral Filters

K. Usami[1,2], Y. Nambu[2,3], S. Ishizaka[2,3], T. Hiroshima[2,3], Y. Tsuda[4,5], K. Matsumoto[4], and K. Nakamura[1,2,3]
[1] *Department of Material Science and Engineering, Tokyo Institute of Technology, 4259 Nagatsuta-chou, Midori-ku, Yokohama, Kanagawa, 226-0026, Japan*
[2] *CREST, Japan Science and Technology Corporation (JST), 3-13-11 Shibuya, Shibuya-ku, Tokyo, 150-0002, Japan*
[3] *NEC Fundamental Research Laboratories, 34 Miyukigaoka, Tsukuba, Ibaraki, 305-8501, Japan*
[4] *ERATO, Japan Science and Technology Corporation (JST), 5-28-3, Hongo, Bunkyo-ku, Tokyo, 113-0033, Japan*
[5] *Institute of Mathematics, University of Tsukuba, Tsukuba, Ibaraki, 305-8571, Japan*

Entanglement plays the most important role in quantum information technologies, such as quantum cryptography, quantum teleportation, quantum dense coding and quantum computation. It is known that the more the state is entangled, the better the state works as a resource for quantum information processing. This poster reports on the experiment of entanglement restoration of a state that potentially possesses more entanglement.

Recently, Kwiat et al. devised an easy and efficient method for producing an arbitrary polarization-entangled state [1–4]. Under cw-pumped SPDC (continuous wave pomped Spontaneous Parametric Down Conversion), the converted photon pair has high purity (low entropy) and high degree of entanglement. On the other hand, it has been reported that under femtosecond pulse-pumped SPDC, the converted photon pair has poor purity and entanglement, due to the complicated dispersion and phase matching associated with an ultra-short pump pulse [5].

This poster reports an experiment of a *disentanglement eraser* [6] which restores entanglement in a bi-photon polarization state generated by two-crystal, femtosecond-pulse-pumped SPDC. Here, narrow-bandwidth spectral filtering play the role of an effective disentanglement eraser, which stretches the coherence time of bi-photon wave packet, and thus erases the information concerning which crystal generates the bi-photon. It is demonstrated that our method effectively restored entanglement, that is, concurrence C [7], and Bell parameter S were increased. Namely, the entanglement of the principal system (polarization state) can be restored from a hidden non-local state ($C \approx 0.21, S \approx 1.6$) to a explicitly non-local state ($C \approx 0.74, S \approx 2.4$) (Fig.1).

In order to obtain reliable estimates of density matrix, C, and S, we used quantum tomography [2,8] and maximum likelihood method [9].

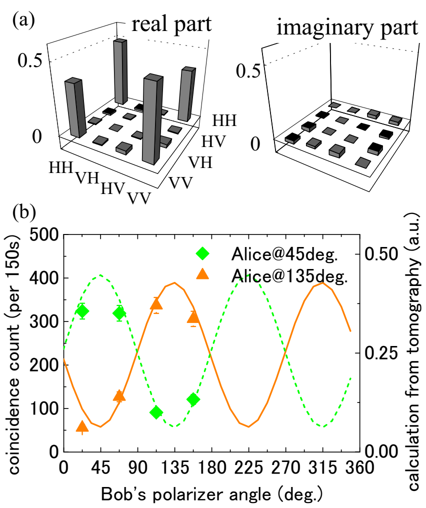

FIG. 1. (a) Density matrix reconstructed by maximum likelihood method (the eigenvalues are 0.869, 0.131, 0, 0) after disentanglement erasing. (b) The results of polarization-correlation measurements for checking Bell-CHSH inequality.

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