Quantum Information Technology using Photons

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We explain the concept of quantum information technology using photons and then introduce our method to generate beam like twin photons using parametric down conversion and the development of high-quantum efficiency multi-photon detection systems.

People started to apply the basic concepts of quantum mechanics (i.e. super position of states, Heisenberg's uncertainty principle) for information processing to realize some functions which can never be obtained using classical mechanics. The uncertainty principle makes it impossible for an eavesdropper to get any information without leaving any evidence of his existence. This concept is so called 'quantum cryptography'. A quantum computer, which utilizes quantum superposition states in a huge Hilbert space of entangled quantum particles for parallel processing, may solve a problem in a minute which can never be solved by a super computer in billions of years.

Our group has been working on the experimental demonstrations of such concepts and development of basic techniques to realize them. An experimental demonstration of a quantum computation algorithm using linear optics and a single photon [1,2], an experimental demonstration of quantum cryptographic system over 1km [3] are the examples. For the practical use of these concepts using photons, single photon generators and high-efficient single photon detectors are important elements. In this talk, we explain our method to generate beam like twin photons using parametric down conversion[4] and the development of high quantum efficiency (88 %) multi-photon detection systems[5,6].

These works were performed in JST-PRESTO project, and the photon detection system was developed in collaboration with JST-ERATO Yamamoto Project at Stanford University, Bowing and Mitsubishi Electric Corporation.

References

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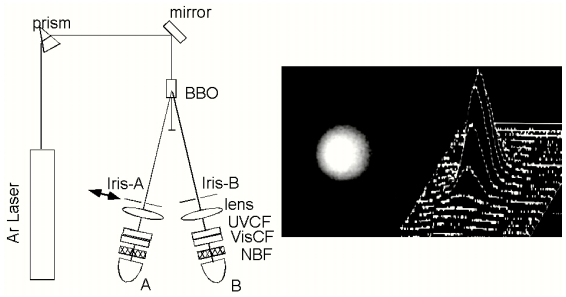

Fig. 1 Beam-like twin photon beam generation

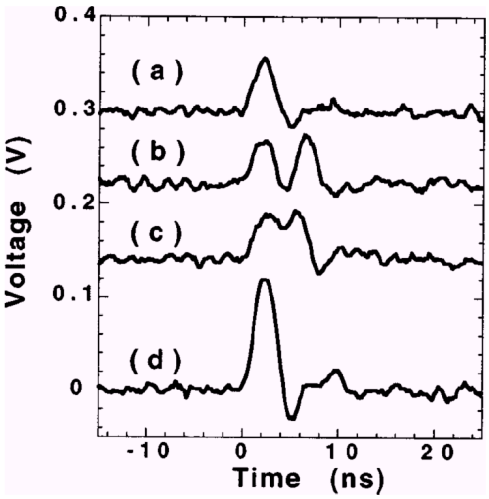

Fig. 2. Photon detection signals from the high-QE multi photon counting system. (a) Single-photon detection signal. (b) 5 ns delay. (c) 3 ns delay. (d) Zero delay.