Enhanced photon number resolving techniques with transition edge sensors for quantum computing and quantum metrology at G-QuAT

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Abstract

A transition edge sensor (TES), which is one of photon detectors, utilizes superconducting transitions to measure the energy of incident light pulses. So far, various types of TES detectors have been developed, targeting photons from the visible to near-infrared ranges. Meanwhile, photon number resolving detectors (PNRD) are defined as detectors that are capable of not only detecting single photons but also discriminating the number of photons in optical packets. Recently, there are increasing demands of PNRD optimized for a tele-communication wavelength in quantum optics field, especially for applications such as quantum cryptography, Gaussian boson sampling and photonic quantum computing.

AIST has launched a new research center, G-QuAT (Global Research and Development Center for Business by Quantum-AI technology), with the aim of developing quantum technologies and rapidly expanding their business. G-QuAT is working on a variety of projects, including large-scale superconducting-qubit quantum computers, quantum computers with neutral atoms, and photonic quantum computers by cooperating with several vendors. For those developments, the implementation of quantum error correction is a very important task and is under a global competition. In the photonic quantum computer, quantum error correction requires the realization of GKP qubits, which requires non-Gaussian states generated by operations based on the nonlinearity of light. One method of generation of the non-Gaussian state is a measurement-induced method by photon subtraction from squeezed state of lights, in which PNRD plays an important role. Thus, an accurate evaluation of PNRD or optical-related components for photonic quantum computers is essential for the correct operation of quantum computers.

In this presentation, we will discuss the status of the photon number resolving detectors using superconducting transition edge sensors and their performance obtained by metrological evaluation methods, which are being conducted in G-QuAT. Especially, we will introduce our efforts to develop TES-PNRDs optimized for an operation at high counting rates, a traceable evaluation method for the detection efficiency using a standard photon source, and an approach using POVM to evaluate the photon number discrimination capability of TES.

References

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