Citation for the 2019 (the 7th) Nishina Asia Award

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For his outstanding contributions to quantum information science with single photons

Quantum mechanics allows a new type of information, quantum information, represented by quantum states that can be superposition of states. Quantum computation, quantum cryptography, quantum communication and quantum sensing are applications of quantum information to perform tasks that are impossible or inefficient with classical counterparts. Physical implementation of quantum information processing requires manipulations of systems at the quantum scale and the manipulation technology has been rapidly developing since the 1990s. At the same time, quantum information science, the study of the novel and sometimes counterintuitive phenomena, such as quantum entanglement, of these quantum systems has emerged and is progressing rapidly. Quantum information science provides new understanding of physics in terms of how the nature of quantum mechanics enables or limits information processing.

Quantum optics is one of the main platforms for quantum information science and technology because single photons are robust against noise. Dr. Chao-Yang Lu has been making many groundbreaking contributions to experimental quantum information science with single photons where quantum information is encoded in the modes of single photon states since the late 2000s starting from his work on generation of quantum multi-photon entanglement. Among his many important contributions, the four recent references on solid-state single photon sources [1, 2], on quantum teleportation [3], and on optical quantum computation [4] should be particularly highlighted.

Single photon sources with high purity, high indistinguishability and high efficiency on demand are the key elements to take advantage of quantum information processing with single photons. However, fulfilling all of these requirements is still demanding and had not been fully achieved. In 2013, Dr. Lu and his collaborators created single photon sources generating pulsed single photons on demand with near unity indistinguishability using a self-assembled InGaAs quantum dot embedded in a planar microcavity [1]. Dr. Lu and his

collaborators made another step in 2015 when they achieved quantum teleportation of quantum information encoded in two distinct degrees of freedom, the spin and orbital angular momentum of a single photon [2] for the first time. Quantum teleportation transmits quantum information by utilizing quantum entanglement and is a fundamental component for many quantum information tasks including quantum repeaters required for long-distance quantum communication. Furthermore, Dr. Lu's group successfully created on-demand single photon sources with simultaneously high purity, distinguishability and efficiency in 2016 [3]. Using these single photon sources, he and his collaborators demonstrated an experimental realization of a quantum computing algorithm, boson sampling for up to 5 photons in 2017 [4], which was a significant step toward exhibiting a quantum advantage of quantum computers.

As presented, Dr. Lu has made many breakthroughs in quantum information science with single photons and has been instrumental in establishing Asian leadership of the global field of quantum information science. For these reasons, Dr. Lu strongly deserves the Nishina Asia Award.

References:

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