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Photonic Quantum Information

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In optics, we study various optical phenomena such as free-propagation, interference, and diffraction. We know that light is well-described within the classical electromagnetic wave theory. In many cases, this holds even when we consider how light field interacts with quantized matter such as atoms. However, we cannot explain some optics phenomena without introducing the concept of quantized light fields, for example, spontaneous emission and nonclassical states of light such as the single-photon state. In quantum optics, we study quantized radiation itself, namely photons, and exploit photons for fundamental studies as well as for applications in quantum information sciences.

In this colloquium, I would like to briefly introduce the quantum information processing based on photons. Specifically, I will present how photonic qubits are prepared, manipulated, and finally measured so that a quantum algorithm is executed in a quantum circuit. After delivering this basic concept, I will also present some of my recent works [1-3] in between-whiles if time is allowed.

[1] Y.-H. Choi, S. Hong, T. Pramanik, H.-T. Lim, Y.-S. Kim, H. Jung, S.-W. Han, S. Moon, and Y.-W. Cho, “Demonstration of simultaneous quantum steering by multiple observers via sequential weak measurements,” Accepted in Optica (2020)

[2] Y.-W. Cho, Y. Kim, Y.-H. Choi, Y.-S. Kim, S.-W. Han, S.-Y. Lee, S. Moon, and Y.-H. Kim, “Emergence of the geometric phase from quantum measurement back-action,” Nat. Phys. **15**, 665 (2019)

[3] Y. Kim, Y.-S. Kim. S.-Y. Lee, S.-W. Han, S. Moon, Y.-H. Kim, and Y.-W. Cho, “Direct quantum process tomography via measuring sequential weak values of incompatible observables,” Nat. Commun. **9**, 192 (2018)