Experimental study of quantum measurement utilizing optical vortex

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1. Objective

Recently, the quantum measurement technique called "weak measurement" has attracted growing interest because this technique makes it possible to directly access the quantum wave function and quantum dynamics. In optical weak measurement, the fundamental Gaussian beam is commonly used as measurement apparatus. In this project, we utilize a special optical beam called optical vortex beam (also known as Laguerre-Gaussian beam) as a measurement apparatus so as to make the optical measurement or the quantum weak measurement more powerful and more functional.

2. Project Outline

To that end, the project will consist of the following phases:

(a) Generation and manipulation of high-quality and higher-order optical vortex beam using spatial light modulator

(b) Observation of unique properties of optical vortex beam, e.g., optical torque due to orbital angular momentum, self-healing effect, tight focusing over diffraction limit, and polarization along propagation direction (z-polarization).

(c) Development of optical multiplexer and demultiplexer (or filter) for the various optical vortex modes.

(d) Optical measurement and quantum weak measurement utilizing optical vortex beam.

3. Required Skills and Knowledge

The successful candidate for this project will have the following knowledge and skills:

(a) Undergraduate level mathematics (calculus and linear algebra)

(b) Quantum physics

(c) Geometric optics, wave optics, polarization optics

References

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(2) H. Kobayashi, K. Nonaka, and M. Kitano, "Helical mode conversion using conical reflector", Opt. Express **20**, 14064 (2012)

(3) H. Kobayashi, G. Puentes, and Y. Shikano, "Extracting joint weak values from two-dimensional spatial displacements", Phys. Rev. A **86**, 053805 (2012)

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