

## **B9 Project Progress Report: Optical Quantum Effect**

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### Goal:

The B9 project on optical quantum effect is intended to demonstrate quantum entanglement, interference, and nonlocality. The outcome of the project is expected to consist of a written report and a written lab script for experiment.

### Experiment Description:

The experiments are conducted on entangled photon pairs generated by passing laser beams through a spontaneous parametric down-conversion setup. For the demonstration of entanglement and violation of locality, the photon pairs are separately measured in various bases of polarization directions, and the statistics obtained from the photon detector can be used to verify Bell's inequality. To show single photon interference, the photon pair enters a Mach-Zehnder interferometer, and interference fringes are expected. Here, the measurements of photon polarization states are done with the help of polarization filters, which consists of waveplates and polarization beam splitters. Besides the above fundamental experiments, more advanced and interesting experiments can be conducted using the existing setup. For example, BB84 protocol in quantum cryptography for key distribution can be effectively implemented.

### Progress:

Although not being able to access the experimental setup yet during vacation, the students prepared themselves by finishing the laser safety training and committing a decent amount of time on an in-depth reading on the references.

### Hilary Term Plan:

Week 1: Familiarize ourselves with the experimental setup, and conduct the experiments that are already available

Week 2-4: Implementation of quantum entanglement, and show Bell's inequality through statistics obtained

Week 5-7: Implementation of quantum interference via Mach-Zehnder interferometer.

Week 8: Potential extension of experiment, and drafting for written report and lab script.