Dr. Xiaosong Ma

Non-local delayed-choice experiments with entangles photons

Supervisor: Anton Zeilinger

ABSTRACT

The complementarity behavior of quantum systems is strikingly illustrated by the so-called quantum eraser, where one can actively choose whether or not to erase which-path information of one particle by performing suitable measurements on the other particle entangled with it. Quantum mechanics predicts that this choice can be arbitrarily delayed and spatially separated from interference. In this thesis, we report the first quantum eraser experiment performed under Einstein locality, i.e. under relativistic space-like separation.

Secondly, we report the realization of Peres' delayed-choice entanglement-swapping gedanken experiment, where one can choose whether or not to entangle two particles after they have been detected and don't even exist anymore. In our experiment, two photons were first measured and 485 ns after the measurements we create entanglement between them via entanglement swapping with a high-speed bipartite state analyzer. The choice between creating entanglement or not is made by a quantum random number generator, and is delayed after the measurements.

Our experiments dramatically underscore the difference between our classical conceptions of space and time, and that in quantum physics.