EXPERIMENTAL OBSERVATION OF THE HONG-OU-MANDEL EFFECT FOR MDI-QKD: TECHNIQUES AND INSIGHTS

Inés Díaz, CSIC
C. de Serrano, 144, Madrid, Spain
T: +34 636514928, ines.diaz@csic.es
Daniel Cano, CSIC
Verónica Fernández, CSIC

Quantum Key Distribution (QKD) leverages quantum mechanics principles to enable the exchange of a secret key between two parties, Alice and Bob, with unconditional security. Unfortunately, conventional QKD setups often fall short of the ideal model requirements due to imperfections in real devices, making them vulnerable to attacks. These vulnerabilities are solved by new Measurement Device Independent (MDI) QKD protocols, which protect the security against detector side-channel attacks and enable secure communication over longer distances. As such, the MDI-QKD protocol involves a third-party relay (Charlie), to whom Alice and Bob send their states. The Hong-Ou-Mandel effect, a quantum interference phenomenon between two photons, holds significance in the context of Bell state measurements crucial for Measurement Device Independent Quantum Key Distribution (MDI-QKD). Achieving the Hong-Ou-Mandel (HOM) interference at Charlie's relay is, therefore, crucial for the protocol's security [1].

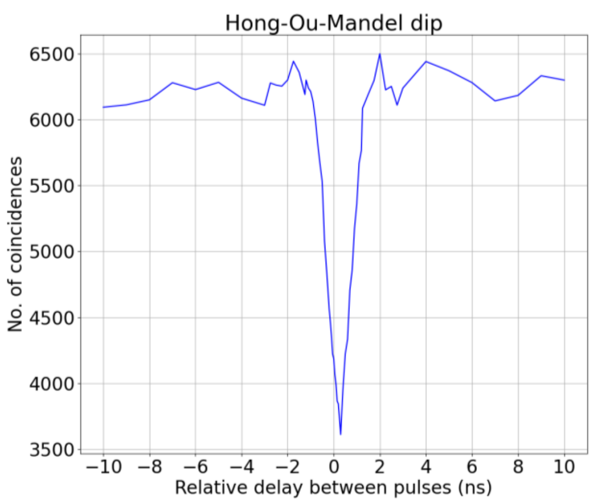

Figure 1 – Experimental Hong-Ou-Mandel dip

In this study, we focused on experimentally observing the Hong-Ou-Mandel effect by optimizing our experimental setup. To observe the Hong-Ou-Mandel effect, we put together an experiment where two indistinguishable weak coherent pulses (WCP) arrive simultaneously at a 50:50 beam splitter (following [2]). When this quantum interference phenomenon occurs, the two photons exit together through a single output, resulting in detection at only one detector. This is graphically represented by the Hong-Ou-Mandel dip [3], which plots the number of coincidence detections against the temporal delay induced in one of the pulses. As we are using WCPs instead of photon number states, the interference contrast is 50%.

We successfully observed the Hong-Ou-Mandel effect by systematically enhancing and replacing various components to improve the visibility of the interference, achieving a clear and pronounced Hong-Ou-Mandel dip. Detailed experimental methods for these improvements are explored, providing valuable insights for future advancements in quantum interference studies in the context of quantum communications.

References

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