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Towards On Demand Generation of Entangled Photon Pairs

Arash Ahmadi[1], Andreas Fognini[2], Mohammad Zeeshan[3], Morgan Mastrovich[1], Sara Hosseini[1], Simon Daley[3], Klaus Jöns[4], Val Zwiller[4] and Michael E. Reimer[3]

[1] Institute for Qauntum Computing and Department of Physics & Astronomy, University of Waterloo, ON, Canada
[2] Kavli Institute of Nanoscience Delft, Delft University of Technology, Delft, The Netherlands (corresponding author)
[3] Institute for Qauntum Computing and Department of Electrical & Computer Engineering, University of Waterloo, ON, Canada[4] Egyptian Petroleum Research Institute, Egypt
[4-]Department of Applied Physics, Royal Institute of Technology (KTH), Stockholm, Sweden

Abstract

Various applications in quantum information require entangled photon sources that meet stringent criteria including brightness, near-unity fidelity, and low multi-photon emission. A quantum light source that meets all of these requirements at once is yet to be developed. In this work we present a source of entangled photon pairs, based on quantum dots in photonic nanowires, with a clear route to meet all of these criteria. Our results indicate that the source generates entangled photon pairs with no dephasing, during the emission lifetime. Therefore, measuring near-unity entanglement fidelity is limitted only by multi-photon emission of the source and the quality of the detection system, i.e. timing jitter and the dark counts. The latter has been largely disregarded in the literature and other features of the quantum dots, such as fine-structure splitting and spins interactions, have been reported to be the main obstacles in measuring perfect entanglement. Moreover, results attributed to resonant two-photon excitation and enhancement of the source in terms of pair-extraction efficiency and multi-photon emission will be presented. Based on our analysis, nanowire QDs have the potential to surpass the performance of spontaneous parametric down conversion sources. Furtheremore, we will also present a novel universal method to erase the fine-structure splitting of QDs using an all-optical approach.

Our results provide more insight into the nature of the two-photon biexciton-exciton cascade and demonstrate a clear path towards reaching perfect entanglement in semiconductor quantum dots in the future for the first time.

Biography:

Arash Ahmadi has completed his PhD at Institute for Quantum Computing in 2019, in Quantum Information. His research on nanowire QDs has lead to enhancing the performance of these sources in terms of entanglement fidelity and pair-extraction efficiency. Moreover, he has contributed to two separate proposals for erasing the fine-structure splitting of QDs.

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