Collective Driving of Many-Photon Quantum States

G. S. Militani[1], C. Evagora[1], R. Schwarz[1], J. Kerber[1], R. G. Krämer[2], S. Nolte[2], P. J. Poole[3], D. Dalacu[3], V. Remesh[1], G. Weihs[1]

[1]*University of Innsbruck, 6020, Innsbruck, Austria*

[2]*Friedrich Schiller University Jena, 07745, Jena, Germany*

[3]*National Research Council Canada, ON KIA 0R6, Ottawa, Canada*

Multipartite entangled photon states are subject of interest for quantum communication protocols, as they are more resilient against hacking threats when compared to classical channels [1],[2]. Semiconductor quantum dots are excellent sources of quantum light states, as they can be deterministically triggered to generate photon states with Fourier limited emission linewidth and high purity. The performance of the emission depends heavily on the excitation technique, so in order to excite multiple emitters at the same time, the so-called adiabatic rapid passage (ARP) presents a highly efficient state preparation [3,4], due to its robustness against spectral inhomogeneity and pulse area variation. One persistent problem in the generation of entangled photon pairs from quantum dots is the fine structure splitting (FSS) [5,6] and it remains unclear what effects ARP has on the photon distinguishability.

Using InAsP quantum dots embedded in InP nanowires [7], the aim of our project is to compare the concurrence of pairs of photons emitted via the biexciton cascade under the ARP and the two-photon excitation (TPE) techniques. Equipped with samples with single and multiple quantum dots stacked on top of each other in the weak-coupling regime, we are investigating the possibility of having a demultiplexed source of entangled photon pairs. Our work paves the way for the scalable generation of multiphoton entangled states for advanced quantum technology applications.

Funding acknowledgement

This work is supported by the Austrian Science Fund (FWF) under Project 10.55776/I4380 (AEQuDot) and Project 10.55776/COE1 (quantA).

References

[1] H. Lo, M. Curty, K. Tamaki, Nature Photon. 8, 595-604 (2014).

[2] V. Zapatero, T. Van Leent, R. Arnon-Friedman, W. Liu, Q. Zhang, H. Weinfurter, M. Curty, Quantum Inf. 9, 10 (2023)

[3] F. Kappe, Y. Karli, T. K. Bracht, S. F. C. da Silva, T. Seidelmann, V. M. Axt, A. Rastelli, G. Weihs, D. E. Reiter. V. Remesh, Mater. Quantum Technol. 3, 025006 (2023).

[4] A. Ramachandran, G. R. Wilbur, R. Mathew, A. Mason, S. O'Neal, D. G. Deppe, K. C. Hall, Sci. Rep 14, 5356 (2024).

[5] E. Schöll, L. Schweickert, L. Hanschke, K. D. Zeuner, F. Sbresny, T. Lettner, R. Trivedi, M. Reindl, S. F. C. da Silva et al., PRL 125, 233605 (2020).

[6] D. Huber, M. Reindl, J. Aberl, A. Rastelli, R. Trotta, J. Opt. 20, 073002 (2018).

[7] P. Laferrière, E. Yeung, L. Giner, S. Haffouz, J. Lapointe, G. C. Aers, P. J. Poole, R. L. Williams, D. Dalacu, Nano Letters 20(5), 3688-3693 (2020).