Photonic Cluster State Generation in the Telecom C-Band

Giora Peniakov[1], Reza Hekmati[1], Johannes Michl[1], Mohamed Helal[1], Moritz Meinecke[1], Jochen Kaupp[1], Yorick Reum[1], Andreas Pfenning[1], Sven Höfling[1] and Tobias Huber-Loyola[1,2]

[1] *Julius-Maximilians-Universität Würzburg, Institute of Physics, Chair of Technical Physics, Würzburg, 97074, Germany*

[2] *Karlsruhe Institute of Technology, Institute of Photonics and Quantum Electronics, 76131 Karlsruhe, Germany*

Photonics is widely regarded as a leading platform for quantum computing and quantum communication (*1*). Unlike many other platforms, which typically implement quantum computation using the circuit model, photonics is particularly well suited to the measurement-based paradigm (*2*). In this approach, qubits are prepared in highly entangled graph states, and quantum computation is performed through sequences of adaptive projective measurements.
A central resource for measurement-based quantum computing is the linear cluster state, consisting of a chain of qubits entangled with their nearest neighbors. Deterministic generation of such states has recently been demonstrated using semiconductor quantum dots (QDs) following the protocol of Lindner and Rudolph (*3*), in which a confined spin mediates entanglement between sequentially emitted photons (*4–6*). While these experiments represent major advances, they were realized in the near-infrared wavelength range, which is suboptimal for many practical applications. In particular, fiber-based quantum communication is most efficient in the telecom C-band around 1550 nm, where attenuation in silica fibers is minimal.

In this talk, I will present our recent progress on generation of a cluster state directly in the telecom C-band. This is achieved through repetitive excitation of a hole spin confined in an indium-arsenide quantum dot subjected to an external magnetic field. We characterize the cluster state by measuring its quantum process map. While measuring the process map, the spin-photon entanglement between a single photon and the spin is also measured and here, we observe spin–photon polarization entanglement with a negativity of $\mathcal{N} = 0.27 \pm 0.02$.

References

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