Photonic quantum computing

Quantum physics has revolutionized our understanding of information processing and enables computational speed-ups that are unattainable using classical computers. In this talk I will present a series of experiments in the field of photonic quantum computing.

The first experiment is in the field of photonic state engineering and realizes the generation of heralded polarization-entangled photon pairs [1]. It overcomes the limited applicability of photon-based schemes for quantum information processing tasks, which arises from the probabilistic nature of photon generation.

The second experiment uses polarization-entangled photonic qubits to implement blind quantum computing, a new concept in quantum computing [2, 3]. Blind quantum computing enables a nearly-classical client to access the resources of a more computationally-powerful quantum server without divulging the content of the requested computation.

A third experiment shows how the concept of blind quantum computing can be applied to the field of verification. A new method is developed and experimentally demonstrated to verify the correctness and the entangling capabilities of a quantum computer [4].

Finally, I will present an experiment realizing a measured universal two-qubit photonic quantum processor by applying two consecutive CNOT gates to the same pair of polarization-encoded qubits. To demonstrate the flexibility of our system, we implement various instances of the quantum algorithm for the solving of systems of linear equations [5].

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[3] S. Barz, E. Kashefi, A. Broadbent, J. Fitzsimons, A. Zeilinger, and P. Walther, Science 335, 303 (2012)

[4] S. Barz, J. Fitzsimons, E. Kashefi, and P. Walther, Nature Physics, AOP, DOI: 10.1038/nphys2763 (2013)

[5] S. Barz, I. Kassal, M. Ringbauer, Y. O. Lipp, B. Dakic, A. Aspuru-Guzik, P. Walther, arXiv:1302.1210