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All-optical Quantum Computation and Quantum Communication

Photons have various significant advantages. They can easily be prepared in a variety of different quantum states including entangled ones with very high purity. Also, photonic states can easily be manipulated. Furthermore, photons are the only type of qubits which can be transported over kilometer distances. Hitherto photons have therefore become the backbone in quantum communication protocols. Distances of the order of 100 kilometershave been possible so far and quantum communication via satellites appears to be technically feasible in pribciple. The use of photonic qubits as the main information carrier in quantum computers has thus far been very limited essentially because of the unavailabilty of significant nonlinearities on the single-photon level. This has changed because of (a) the identification of effective nonlinearity due to the measurement process and (b) the the observation that the randomness of the individual quantum event can be overcome by active feed forward in a cluster state quantum system. All-photonic systemswere both communication and computation are performed by photonic qubits would be very desirable as then transfer of quantum information between different physical implementations of qubits would not be necessary. I will review some recent results and possibilities for the future.