Nanowire quantum dots for multi-qubit photonic devices

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Semiconductor quantum dots are one of the best on-demand sources of single and entangled photons to date, simultaneously merging the highest brightness and indistinguishability of the emitted photons. They are, therefore, among the strongest candidates for practical *single-qubit* quantum photonic devices. However, to exploit the full advantage of quantum physics, *multi-qubit* photonic devices are absolutely necessary. In this talk, I will present our approach for realizing practical *multi-qubit* photonic devices for quantum networks based on nanowire quantum dots.

First, I will show a hybrid system where we combine semiconductor nanowire quantum dots with an atomic vapor [1]. We demonstrate: (1) a controlled growth of GaAs quantum dots in AlGaAs nanowires, (2) their excellent optical properties, and (3) tuning of their emission frequency to the optical transitions of Rb atoms. Such hybrid semiconductor-atomic systems [2] are promising building blocks for quantum networks, enabling, for instance, a realization of an arbitrary number of nanowire single-photon sources, all operating at the same frequency of an atomic transition.

Second, I will present a device where we propose and numerically demonstrate a method for controlled charging of multiple quantum dots and coherent charge transport between the dots [3]. We show that charge loading and charge transport can be implemented in a realistic structure with fidelities greater than 99.9% in a few μs. Our scheme is based on all-optical resonant manipulation of charges in a 1-dimensional array of quantum dots formed by a type-II band alignment. Such structures can be practically realized using, for example, crystal-phase quantum dots in nanowires [4], and are feasible in view of recent advances in controlling the crystal phases in nanowires during growth [5].

Our work opens new practical avenues for realizations of advanced quantum photonic devices exploiting *multiple nanowire quantum dots* such as, for instance, a solid-state quantum register with a photonic interface.

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