Epitaxial Quantum Dots: Nanostructures for Quantum Communication

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Abstract The prospect of using the quantum nature of light for secure communication keeps spurring the search and investigation of suitable sources of single and entangled photons. Semiconductor quantum dots (QDs), also dubbed “artificial atoms”, are arguably one of the most attractive, as they can generate single and entangled photons on demand and they are compatible with current photonic-integration technologies. Unlike “natural atoms”, however, no two QDs are alike. This peculiarity is a major obstacle for quantum communication applications that require non-classical states of light with identical energies.

In this talk, I will first introduce a novel class of semiconductor-piezoelectric devices in which strain is used to engineer the electronic properties of any arbitrary QD so that single and polarization-entangled photons can be generated with unprecedented quality and speed. Then, I will show how full control over the QD in-plane strain tensor allows the energy of the entangled photons emitted by QDs to be precisely controlled in the spectral range in which a cloud of natural atoms behaves as a slow-light medium. To conclude, I will present our recent results on droplet-etched QDs and discuss how they can be used to construct a QD-based quantum network.