Interfacing elements in a quantum network based on an atomic frequency standard

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Quantum memories will play a central part in synchronizing operational events in quantum networks, e.g. joint measurements between photons from different sources in order to implement entanglement swapping in quantum repeater protocols [1]. A promising platform relies on electromagnetically induced transparency (EIT) in atomic vapor. There, transitions in Rubidium or Cesium between 800 nm 900 nm provide a convenient wavelength to link the memories to other photon emitters like molecules or quantum dots [2]. In this way the most promising system for pure and fast few-photon sources, i.e., semiconductor quantum dots, can be linked to efficient storage devices in a hybrid approach. In our contribution we introduce our recent experimental results in this direction.

First, we demonstrate precise strain-tuning of InGaAs quantum dot emission between two 1.2 GHz hyperfine-split D1 transitions in Cesium vapor at room temperature. Then we show how single photons from the quantum dots can interact with a Cesium cell [3] providing a novel approach to access strong delays even close to room temperature. These recent experiments lay the ground for atomic vapor-based quantum memories in hybrid quantum networks [2] with storage times up to hundreds of microseconds and efficiencies of about 35 %.

In a second part of the contribution we also introduce our results concerning the conversion of single photons at Cesium wavelengths from quantum dots to the telecom band at 1550 nm [4]. Both experiments lay the ground for hybrid quantum networks involving atomic memories, semiconductor quantum dots, and long-distance fiber transfer.

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