Stuttgarter Physikalisches Kolloquium

Fachbereich Physik, Universität Stuttgart
Max-Planck-Institut für Festkörperforschung
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Atomic-Ensemble-based Optical Memories for Interfacing Semiconductor Quantum Dot Single Photons

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Abstract

Light is a promising platform for future quantum-enhanced technologies due to its speed, high information capacity, resilience to room-temperature environments, and robustness over metropolitan distances. However, the efficient generation and manipulation of indistinguishable photons remains probabilistic, while the distribution of photons over continental scales suffers inherent channel-propagation losses. These limitations result in a low success probability for composite photonic systems and pose a barrier to scalable photonic quantum technology.

Quantum optical memories offer a potential solution to this scaling issue by utilising light-matter interactions to store and recall quantum states of light on-demand. This allows for multiplexing over non-deterministic processes for synchronising quantum networking operations. Atomic-ensemble-based systems are well-suited for such devices as light can be efficiently mapped into and stored as long-lived excitations within the atomic medium.

Hot alkali vapours combine strong light-matter interactions, high-bandwidth (~ GHz) implementation and moderate-temperature operation for technical simplicity, making them an ideal platform to interface with semiconductor quantum dot light sources. In this talk, I will discuss different approaches to quantum memories, including rephasing-based protocols and two-photon absorption mechanisms. I will present our latest work using hot rubidium atoms to store telecom wavelength pulses at the single photon level [5] as well as storing and recalling semiconductor quantum dot single photons for the first time.