Colloquium on Solid-State Physics

Department of Physics
SS 2022

Thursday, 5th May 2022, 17.15 h
Lecture Hall III, Department of Physics, Garching

Solid-State Quantum Memories for Quantum Repeaters

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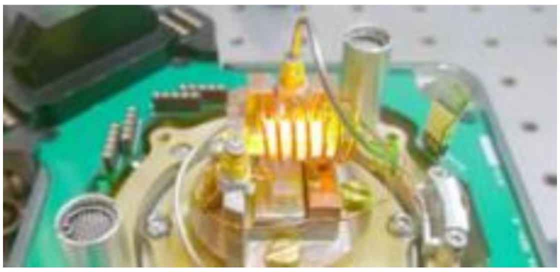
Abstract:
Optical quantum memories are devices that can store and later retrieve quantum states encoded onto single photons. These are essential components of future quantum technologies such as quantum repeaters, which can increase quantum communication (e.g. quantum cryptography) to continental distances. To build an efficient and long-lived quantum memory remains a great challenge, particularly using solid-state devices.

In this talk, I will briefly introduce quantum communication and the motivation behind building a quantum repeater. I will also introduce some basic concepts behind quantum memories that use ensembles of atoms, and in particular, rare-earth-ion (RE) doped crystals. RE-doped crystals are promising solid-state quantum memories, owing to their long optical and spin coherence times. Quantum repeaters based on RE crystals represent the main research directions for quantum repeaters within the EU Quantum Flagship program.



I will show some experimental results from my group at University of Geneva, where we recently achieved storage of light pulses at the single-photon-level for up to 100 milliseconds in a $Eu^{3+}:Y_2SiO_5$ crystal, which is known for its long spin coherence time. A drawback to this material, however, is its low bandwidth. Recently we discovered a new material where higher bandwidths can be achieved - $^{171}Yb^{3+}:Y_2SiO_5$. In this material, we recently demonstrated quantum correlations between telecom photons propagating through an optical fiber and 980 nm photons stored in the $^{171}Yb^{3+}:Y_2SiO_5$ crystal, over a fiber distance of 5 km. Building on this experiment should allow distributing entanglement between remote quantum memories, a key resource for quantum repeaters.

There will be coffee, tea, and cookies in front of the lecture hall at 17.00 h

gez:
Nadezhda Kukharchyk (Host)