SEMINAR | From single-photon sources to photon-photon interactions: Enhancing light-matter coupling with solid-state emitters on optical nanofibers

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12:00 to 13:00
Elements Room

Solid-state quantum emitters are promising building blocks for scalable quantum photonics, but their practical use is often limited by inefficient photon extraction and insufficient light-matter interaction strength. Reaching the regime where a single emitter significantly modifies a propagating optical field requires maximizing coupling to a well-defined mode while engineering the local density of optical states.

In this talk, I will present our approach based on tapered optical nanofibers, subwavelength singl-mode waveguides that provide direct compatibility with fiber networks. Emitters coupled to their evanescent field can already reach ?-factors on the order of 20-30%, while maintaining a simple and low-loss geometry.

To further enhance light-matter interaction, we explore two complementary nanophotonic strategies. First, we pattern dielectric nanostructures directly on the nanofiber to locally tailor the electromagnetic environment and increase emission into the guided mode. Second, we deposit diamond nanophotonic waveguides hosting quantum emitters onto the nanofiber, combining the favorable optical properties of diamond with efficient fiber coupling. These two approaches provide distinct routes to increase LDOS and mode overlap, and to push the system toward higher ?-factors.

Together, these developments aim at entering a regime where a single emitter acts as a strongly nonlinear optical element. When this waveguide QED regime is reached, photon-photon interactions can be mediated at the single-emitter level, opening a path toward deterministic nonlinear optics and the generation of highly non classical states of light in a fiber-integrated platform.

Hosted by: Prof. Dr. Darrick Chang and Prof. Dr. Hugues de Riedmatten