Quantum optics meets sensing: Applications of fiber-based Fabry-Perot Cavities

Jonathan Noé[1*], Michael Förg[1], Ashly Jose[1], Ines Amersdorffer[1,2], Manuel Nutz[1], Thomas Hümmer[1], David Hunger[3], Theodor W. Hänsch[2]

[1] Qlibri GmbH, Munich, Germany

[2] Ludwig Maximilian University of Munich, Munich, Germany

[3] Karlsruhe Institute of Technology, Karlsruhe, Germany

High-finesse, open-access, mechanically tunable optical microcavities provide a powerful platform to enhance light–matter interactions in a wide range of systems, from single atoms [1] to solid-state crystals [2,3] and measurements in liquid environments [4]. In this seminar, we will explore various application examples of fiber-based microcavities.

By combining a scannable, microscopic fiber mirror with a macroscopic planar mirror, we create a highly versatile experimental setup. At room temperature, this configuration enables precise measurements of phenomena such as the absorption properties of single perovskite crystals, defect concentrations in transition metal dichalcogenide layers, and the dynamic behavior of configurations of lipid layers in solution.

When adapted to a cryogenic environment using closed-cycle cryostats, the system faces new challenges in terms of position control and mechanical stability. We present a fully 3D-scannable, yet highly stable microcavity setup, including recent enhancements such as the integration of magnetic fields. This advancement enables fast and reliable access to both the weak and strong light–matter coupling regimes in various solid-state systems.

Finally, by replacing the planar mirror with a second fiber mirror, the system can be tailored for sensing applications and for coupling to ultra-small particles, including single atoms. We will discuss the specific challenges and technical requirements for the fiber mirrors and their mounting systems in these specialized experiments.

[1] Grinkemeyer et al. Science 387.6740 (2025)

[2] Förg et al. Nature communications 10.1 (2019)

[3] Husel et al. Nature communications 15, 3989 (2024)

[4] Needham et al. Nature 629.8014 (2024)

*Email: noe@qlibri.eu