Quantum optics meets microscopy: An ultra-sensitive micro-resonator platform by Qlibri

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High-finesse, open-access, mechanically tunable, optical micro-cavities offer a compelling system to enhance light-matter interaction in numerous systems, such as quantum repeaters, single-photon sources, quantum computation [1,2,3], and hyperspectral maps of absorption for nanoscale solid-state systems [4,5]. The combination of high sensitivity and strong field enhancement makes them ideal for exploring exciton and polariton properties.

We present a fully 3D-scannable, yet highly stable micro-cavity setup, which features stability on the sub-pm scale under ambient conditions and on the pm-scale within closed-cycle cryostats.
An optimized mechanical geometry, custom-built stiff micro-positioning, vibration isolation and fast active locking enable quantum optics experiments even in the strongly vibrating environment of closed-cycle cryostats. Combined with a finesse up to 100,000 even the weakest absorbance is enhanced providing insights into individual nanoscale systems while guaranteeing minimum photodamage.
A large variety of solid-state and nano-scale quantum systems can be brought onto the planar mirror, analyzed, addressed individually, and (strongly) coupled to the cavity. The potential of this platform is illustrated by the strong coupling of quantum emitters and dynamic control of purcell enhancement and hyperspectral imaging of 2-dimensional heterostructures, perovskites, individual carbon nanotubes, and protein crystals. These capabilities open new avenues for studying exciton-mediated interactions, quantum coherence, and optomechanical effects in solid-state and low-dimensional systems.

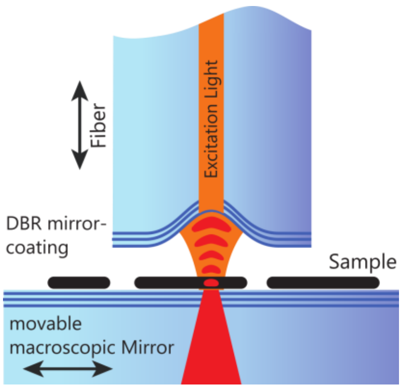

Figure 1: Schematic of a micro-cavity containing a fiber mirror and a planar mirror hosting a sample.

References

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