**Hybrid Cavities for Polaritonics**

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Traditionally, light-matter interactions are enhanced by coupling emitters to photonic microcavities [1]. The optical modes supported by these dielectric devices typically reach large enhancements because of their long photon lifetimes and high quality factors (Q~1000). Moreover, most of the light emitted by these systems channels into a single cavity mode, facilitating its efficient collection through, for example, a photonic waveguide. On the other hand, plasmonic nanocavities have lately become an alternative route offering new strategies to mold and manipulate light-matter coupling. Instead of retaining photons for very long, metal nanostructures are able to confine their energy in volumes well below the diffraction limit (V~ 10 nm3), thus achieving unprecedented coupling strengths. Contrary to microcavities, metallic nanocavities [2] support a rich spectrum of optical modes within frequency windows comparable to their natural bandwidths, and with very different spatial profiles.

Both photonic microcavities and plasmonic nanocavities present important flaws. The former are limited in their mode volume and, although they can exhibit large Q-factors, they are often extremely sensitive to minor fabrication errors and changes in temperature or environment. The latter suffer from strong dissipative losses, which limit their quality factor. For polaritonic applications, one would like to have access to QED cavities combining a large Q-factor, small modal volume, high robustness to environment and imperfections, and a well-behaved emissivity. A successful strategy to realize such devices consists in combining and hybridizing both photonic and plasmonic elements into single QED cavities [2].

In this TFM project, light-matter coupling in various designs of hybrid photonic-plasmonic cavities will be explored by numerical and analytical means, with special focus on quantum optical applications.

[1] A. V. Kavokin et al., *Microcavities* (Oxford University Press, 2007).

[2] R. Sáez-Blázquez et al., Phys. Rev. A 98, 013839 (2018).

[3] H. M. Doeleman et al., ACS Photonics 3, 1943 (2016).