Plasmonic cavities and individual quantum emitters in the strong coupling limit

Ora Bitton[1], Satyendra Nath Gupta[2], Santhosh Kotni[2] and Gilad Haran[2]

(1) Chemical Research Support department, Faculty of Chemistry, Weizmann Institute of Science, Rehovot, Israel

(2) Department of Chemical and Biological Physics, Faculty of Chemistry, Weizmann Institute of Science, Rehovot, Israel

Ora.Bitton@weizmann.ac.il

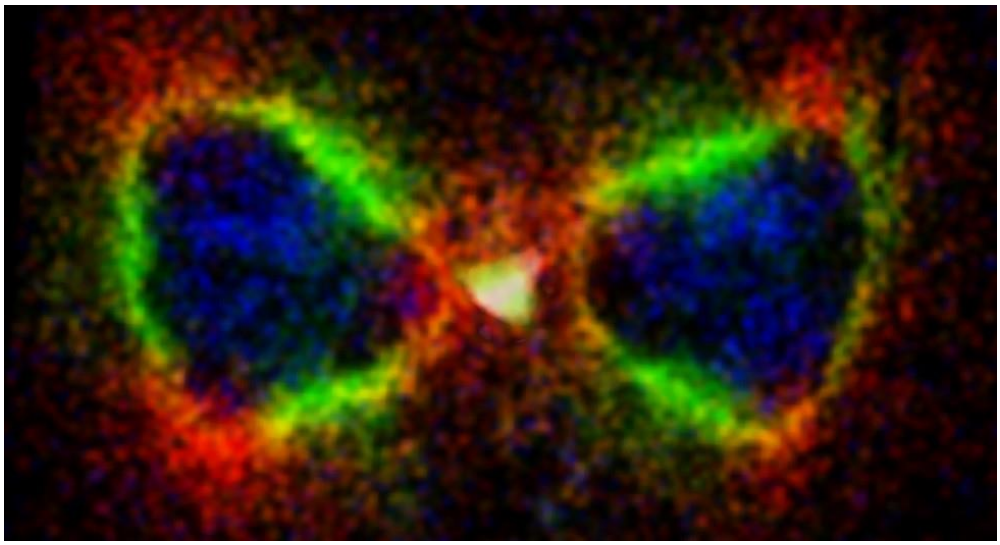
The strong interaction of individual quantum emitters with resonant cavities is of fundamental interest for understanding light–matter interactions. Plasmonic cavities (PCs) hold the promise of attaining the strong coupling (SC) regime even under ambient conditions due to their deep subdiffraction volumes. We previously showed that we can observe SC in the limit of a single quantum emitter positioned within a plasmonic cavity. Scattering spectra, measured by dark-field spectroscopy and registered from individual PCs containing one to a few colloidal quantum dots (QDs) showed vacuum Rabi splitting, indicating that the SC regime was approached in these systems.

To verify and generalize our findings, we turned to Electron Energy Loss (EEL) spectroscopy which enables us to probe SC not only to the bright modes of plasmonic structures but also to dark, subradiant modes. This may be of significant interest for quantum optical studies, particularly since they are expected to have longer lifetimes.

Spectroscopic studies of the QD-PC systems manifested several surprising features, indicating discrepancies between scattering and photoluminescence spectra. These observations point to the involvement of a dark excitonic state of the QD and to complex relaxation pathways and interesting dynamics.

Currently we are working on increasing the QD-PC coupling deeper into the SC regime. This can be acheived either by optimizing the materials properties of the plasmonic system or by forming hybrid plasmonic-photonic modes. This will pave the way to exciting applications including the generation of single-photon sources and studies of cavity-induced coherent interactions between emitters.

Keywords: light-matter interaction, plasmonics, electron energy loss spectroscopy (EELS), strong coupling



Mapping of electromagnetic near field of a silver bowtie structure. Each color represents a different plasmonic mode. A QD is trapped in the gap of the Silver bowtie.