Quantum coherence and interference (QCI) effects in atomic and molecular physics have been extensively studied because of intriguing counterintuitive physics and potential important applications [1,2]. Recently the domain of QCI has extended from conventional atomic, molecular and optical (AMO) physics to plasmonics and metamaterials which has its inherent advantages like room temperature operation, large bandwidth etc. Theoretical proposal of quantum-coherence enhanced SPASER [3] and propagating surface plasmons (SPs) [4] would connect the techniques used in quantum optics with the technical advances in the field of nanoplasmatics and manipulation of nanostructures.

Here, I will discuss two physical configurations in which the role of QCI in the medium near a gold sphere (Fig 1a) and a gold strip (Fig, 1b) in enhancing the localized and propagating SPs.

Physically the three-level systems experience Fano-type interference in their absorption profile that generates an asymmetry between absorption and stimulated emission. This asymmetry mitigates the SPPs absorption, thus reducing the radiative damping of SPs in (1a) and SPPs in (1b). As shown in Fig 1(a), the driving field also controls the spaser dynamics, which may lead to future ultrafast and controllable nanoplasmonic devices. The coherent drive, acting as external control parameters, holds promise for quantum control of nanoplasmonic devices. These concepts can be extended to a broader range of quantum optical phenomena and applied to a variety of plasmonic nanostructures for alter the light-matter interaction. Such effects with atoms and phaseonium-coupled meta-atoms bring a new regime of engineering the optical properties of hybrid systems [5].

References: