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Frank Isakson Prize: Quantum Plasmonics and Plexcitonics

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Plasmon energies can be tuned across the spectrum by simply changing the geometrical shape of a nanostructure. Plasmons can efficiently capture incident light and focus it to nanometer sized hotspots which can enhance electronic and vibrational excitations in nearby structures. The plasmon energies and induced electric field enhancements can be strongly influenced by quantum mechanical effects such as electron tunneling across narrow junctions and non-local screening of the electromagnetic fields near the surfaces of the nanostructures. Large molecules can exhibit molecular plasmon resonances that exhibit classical-like behavior but have a quantum mechanical origin. The coupling of plasmonic and excitonic systems can lead to hybrid states referred to as "plexcitons" which can exhibit quantum mechanical effects and nonlinear optical properties. Another important but still relatively unexplored quantum mechanical property of plasmons, is that they can be efficient sources of hot energetic electrons which can transfer into nearby structures and induce a variety of processes. In the talk, I will discuss various quantum mechanical effects in plasmonic systems and how they can be exploited in applications: such as to induce chemical reactions in molecules physisorbed on a nanoparticle surface; to inject electrons directly into the conduction band of a nearby substrate; to dramatically enhance the light harvesting efficiency of photonic devices; to induce local doping of a nearby graphene sheet; and to induce phase transition in adjacent media.