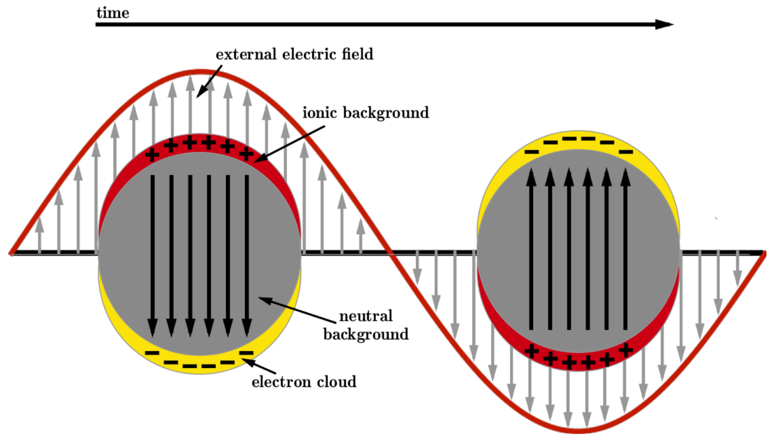
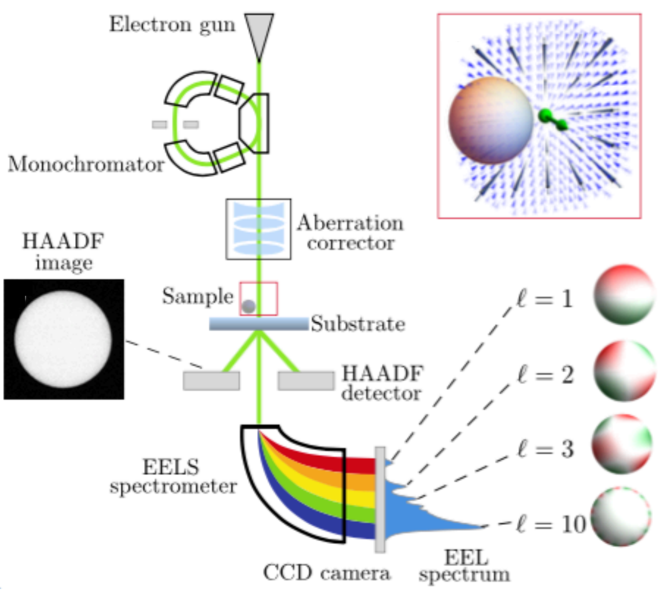
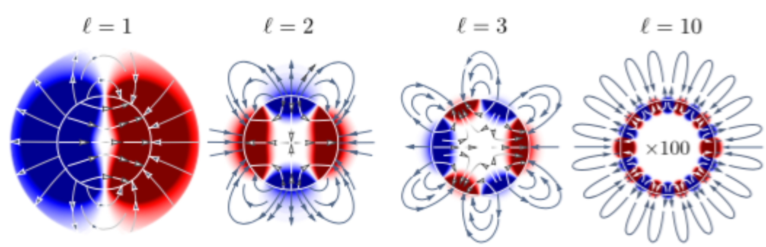
Plasmonics in the Masiello Group



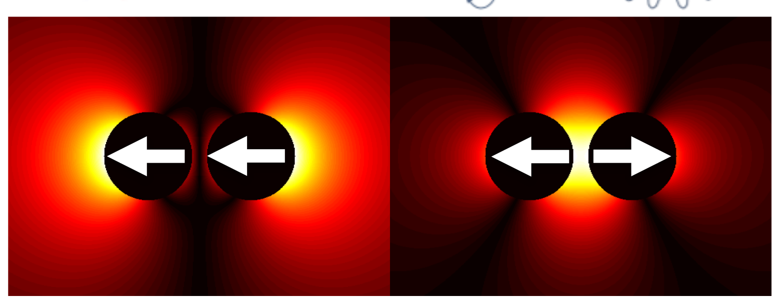
The Masiello group is interested in the behavior of electrons in metals. When metals are exposed to an electric field, the electrons move in attempt to screen the electric field in the metal. When this field is oscillating, such as is the case for light or electron beams, the electrons in the metal oscillate as a result. When this oscillation occurs at particular resonance frequencies, the collective oscillation of electrons in the metal is known as a plasmon.



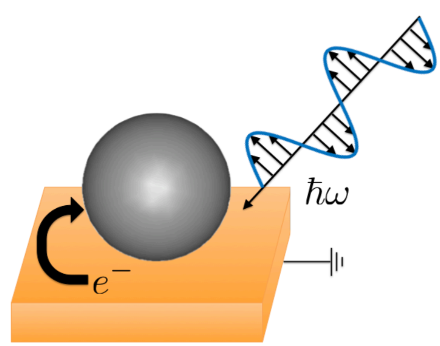
The electron beam, with schematics on the left, proves a useful tool for analyzing plasmonic systems. The electron beam uses high energy electrons that interact with metal nanoparticles and either result in high angle deflection, that is used for imaging, or low deflection that is used for electron energy loss spectroscopy (EELS). EELS measures the amount of energy that an electron loses when interacting with a metal, exciting a plasmon. This provides information regarding the energy and frequency of oscillation of the metal's conduction electrons. Due to the localized nature of the electric field of the electron beam, more information can be gathered regarding the behavior of plasmonic systems from EELS than can be gained from light.



EELS allows for the excitation of different types of oscillations, or different modes of excitation on metal nanoparticles. It is capable of exciting bright modes, which are excitable by light, and dark modes, which are not excitable by light.



EELS is also dependent on the location of the electron beam with respect to the metal nanoparticle. This reveals spatial information contained in energy filtered EEL maps for specific modes. This allows hybridization between modes of metal nanoparticles to be observed through measuring the degree of interaction in space.



Understanding the nature of plasmons interacting with electric fields helps us study applications in solar energy, such as the Plasmoelectric effect. This utilizes plasmon-semiconductor systems driven by light to create measurable potentials on the nanoscale. By understanding and engineering systems with favorable spectral features, we can enhance the magnitude of this potential allowing for an additional method of solar energy harvesting.