FACOLTÀ DI SCIENZE MATEMATICHE, FISICHE E NATURALI
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Optical investigation of electronic excitation in metal nanoparticles

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Abstract

The strong modification with size reduction of the optical response of metal nanoparticles has led to considerable interest in the academic and industrial domains. The most conspicuous feature is the appearance of a confinement induced resonance, the surface plasmon resonance (SPR), whose spectral properties (wavelength, width, absorption and scattering cross-sections) reflect the characteristics of the particles (composition, size, shape) and of their environment. These dependencies, which will be discussed in the introduction of this talk, have been extensively exploited to design new optical materials or to create nanosensors, opening the fields of nanophotonics and plasmonics.

These optical features also constitute efficient tools to investigate the impact of size reduction on the fundamental properties of nanoparticles. However, because of the very weak optical response of a single nanoparticle, most investigations have been performed by simultaneously probing a large number of particles. Due to the unavoidable particle to particle fluctuations of the geometry and environment, only a mean response is obtained, masking the details of the individual particle behavior. These limitations can be overcome by investigating a single nanoparticle, which requires development of very high sensitivity optical detection schemes. After recalling the principles of the recently developed methods permitting to detect light scattering or absorption by a single particle, we will focus on a far-field optical technique, the spatial modulation spectroscopy. This permits quantitative measurements of the extinction cross-section of the particle under study and precise comparison with the theoretical models when its morphology is independently determined, for instance, by electron microscopy. It opens the way to determination of intrinsic processes in nanoparticles, such as the role of quantum effect on the SPR bandwidth, and to the study of particle – surface interactions. Extension of these investigations to the nonlinear optical response of a metal nanoparticle will also be discussed.

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