Institut für Physik

Montanuniversität Leoben

A-8700 LEOBEN, Franz Josef Straße 18, Austria
Tel: +43 3842 402-4601, Fax:+43 3842 402-4602
e-mail: physics@unileoben.ac.at

S E M I N A R
aus
Halbleiterphysik und Nanotechnologie

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"Plasmon-phonon strong coupling: a tool to modify the intrinsic properties of nanomaterials"

Dr. Andrea Cerea

Italian Institute of Technology (IIT), Genova, Italy

Nowadays, the study of the basic mechanisms of light-matter interaction is an interdisciplinary topic addressed in the fields of optical and atomic physics, condensed matter physics, optoelectronics, communication, molecular biology and medicine. Within this context, plasmonics offers a viable route for the manipulation of the electromagnetic field through the resonant interaction between metallic nanostructures and incident radiation. The near-field characteristics of plasmon based devices, together with associated high enhancement and squeezing of electromagnetic fields in sub-wavelength areas, and the straightforward tunability of their plasmonic properties across a wide spectral range make them particularly suitable for the investigation of light-matter interactions at the nanoscale level. Recent advances in nanofabrication techniques have paved the way towards the realization of designs that boost light-matter interactions to the strong coupling regime, leading in the last decades to fundamental discoveries, such as threshold-less nano-lasers, single-photon optical transistors and modification of the electronic properties of nanomaterials. Through the formation of hybrid states and by inducing significant modifications in the intrinsic properties of each constituent, light-matter strong coupling offers challenging perspectives. Very recently, this concept has been extended from the visible spectral range, where emitting materials operate, to the infrared and terahertz spectral range, where most of the vibrational and dissipative properties lie, offering the possibility to engineer the nanoscale phononic characteristics of hybrid materials and enhance the performance of solid-state devices. In this presentation we address this issue and we show how vibrational strong coupling can be exploited to modify the phononic properties of materials. In this respect, the dipole-active phonon resonance of semiconducting nanocrystals can be drastically reshaped, just by means of the vacuum electromagnetic field confined in properly designed THz plasmonic nanocavities. A Raman characterization of the coupled system unveils the quantum nature of the investigated phenomena, demonstrating that strong hybridization occurs even in far-off resonance conditions.