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Acoustic phonons Raman scattering

Acoustic vibrations with frequencies ranging from few hundreds of GHz to few THz have wavelengths varying from few tens of nanometers to few nanometers depending on the material sound velocities. Hence, these sound waves are well adapted probes of nano-objects (Quantum wells, semiconductor quantum dots, metal nanoparticles) and can be excited and detected using optical techniques (e.g. Raman/Brillouin, time resolved pump-probe experiments). In this talk, I will present recent advances in the use of acoustic phonons Raman/Brillouin scattering as a tool for nanoscale metrology. I will first introduce the basic concepts of interaction between extended acoustic vibrations and electronic states in semiconductor quantum wells and in self-organized quantum dots. In these nanostructures, because the coherence lengths of light and sound are much larger than typical correlation lengths of the excited electronic states, the inelastic light scattering process is spatially coherent, thus leading to interference effects in the scattered intensities. This property is used to extract the size and the spatial distributions of nano-objects from the spectral feature of the low-frequency Raman/Brillouin scattering.
Acoustic vibrations can also be confined to nano-objects. Their density of states is then discretized and size effects are very important. The confinement of acoustic vibrations in two dimensions is clearly observed by inelastic light scattering in silicon/silicon oxide layers and in
silicon membranes. These structures are widely used in the silicon based micro-electronic industry, thus providing a good example of the use of fundamental concepts for applications in nanotechnology. The presentation will include metallic nano-objects where the resonant Raman scattering is due to surface plasmons and to their interactions with confined acoustic vibrations.

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