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New horizons in the manipulation of GHz-THz acoustic nanowaves

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The development of micro- and nanofabrication techniques enabled the study of nanostructures where it is possible to engineer the acoustic phonon dynamics - acoustic waves with nanometric wavelengths and frequencies in the GHz-THz range). In these structures it is also possible to engineer the photonic properties and control both the dynamics and the interactions between the photonic and phononic fields. Picosecond ultrasonics tools gave direct access to the study of phonon propagation both in the time and frequency domains, and to the spatial distribution of strain in nanostructures.
In this presentation I will introduce new strategies to engineer and study semiconductor nanostructures capable of confining, controlling the propagation, and manipulating acoustic phonons in the GHz-THz frequency range. Superlattices work as high reflectance phononic mirrors and constitute a fundamental building block for the conception of more complex devices. Acoustic cavities are capable of confining and amplifying the hypersound field both spatially and in the spectral domains. Usually, an acoustic cavity is formed by two identical distributed Bragg reflectors embedding an acoustic spacer, acting in a similar way to a Fabry-Perot resonator. We design a novel kind of phononic cavities where no spacer is needed, based on the engineering of the phonon phase in the interface between two superlattices. Such kind of resonators can be combined in coupled-acoustic cavity structures such as molecules and coupled-resonator waveguides able to evidence novel physical phenomena such as acoustic Bloch oscillations.