TEACHING ELECTRONS AND PHOTONS NEW TRICKS WITH STATE-OF-THE-ART TECHNOLOGY: QUANTUM CASCADE LASERS, OPTICAL MICROBILLIARDS, AND QED-BASED NANOMECHANICS

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State-of-the-art semiconductor nanostructures based on molecular beam epitaxy (MBE) and microelectromechanical systems (MEMS) based on silicon integrated circuit technology have made it possible to achieve unprecedented control of the boundary conditions of electrons and photons. This has led to the design of new artificial materials and quantum devices with tailored properties, to microstructures in which controlled deformation are used to exploit wave-chaos phenomena for photonic applications and to micromachines based on vacuum fluctuations.
I will illustrate the above with examples from our research: (a) Quantum Cascade Lasers, fundamentally new light sources that cover the entire wavelength range from the mid to the far infrared by tailoring layer thicknesses; (b) Asymmetric microresonators in which KAM transition to chaos, "scars" and high directional emission from bow-tie modes have been observed; (c) High precision measurements of Casimir forces with MEMS and the demonstration of new actuators and sensors that exploit these forces.

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