Chip-integrated Nanophotonic Structures for Classical and Quantum Devices

Antonio Badolato
Department of Physics and Astronomy, University of Rochester, Rochester, USA
antonio.badolato@gmail.com

Chip-integrated nanophotonics investigates the interaction of light with nanostructures integrated on a chip. Lying at the intersection of condensed matter physics, optics, nanotechnology, and materials science, nanophotonics draws upon expertise from broad areas of physics and engineering, while presenting major opportunities to advance fundamental physics and transformative photonic technologies. In this talk, I will focus on our experimental research in two areas of nanophotonics.

First, I will show that nanostructured semiconductors, such as quantum dot heterostructures coupled to photonic crystal nanocavities, can now offer unprecedented level of control of light-matter interaction at the single photon level [1,2]. Our artificial atoms deterministically coupled to nanocavities modes provide foundations for novel photonic quantum devices, namely, nanostructures that harness quantum coherence for their core operation while exploiting photonic functionalities.

Second, I will present experiments demonstrating record-high performance of on-chip photonic crystal nanostructures uniquely designed by genetic evolution algorithms. Such devices achieve light confinement with quality factors up to 2 millions [3] and structural slow-light with large group index–bandwidth product. I will show how the resulting nanophotonic platforms enable silicon-based applications ranging from CMOS-compatible single photon sources to label-free biosensing.