



Birck Nanotechnology Center

Dr. Vladimir A. Aksyuk Seminar

Title: Integrated Photonic and Plasmonic Signal Transduction for Micro- and Nanomechanical Sensing

Monday, January 29th, 2018

11:30am – 12:30pm, BRK 1001

Bio: Vladimir Aksyuk is a Project Leader at the NIST Center for Nanoscale Science and Technology. He received a B.S. from Moscow Institute of Physics and Technology and a Ph.D. in Physics from Rutgers University, and worked as a Technical Manager at Bell Laboratories prior to joining NIST. Vladimir's research focuses on microsystems tightly coupling optical, plasmonic, electrical, thermal and mechanical degrees of freedom at the nanoscale. He received a Distinguished Alumni award for early career accomplishments from Rutgers and the Bell Labs President's Gold Award, was named among MIT Technology Review magazine's TR35, and awarded a Bronze Medal by NIST. He is a Fellow of the American Physical Society recognized for contributions to the development of integrated photonic and mechanical microsystems, for pioneering work in using such systems to enable both telecommunications and novel nanoscale, high-throughput measurement methods, and for contributions to the understanding of the Casimir force.

Abstract: Measuring unknown quantities by coupling them to mechanical motion dates back at least 5000 years: simple equal-arm balances used for weighing goods in ancient Egypt are in fact mechanical measurement tools, with motion detected optically by the human eye. Modern microfabrication enables sophisticated, high performance 100 micrometer scale physical sensors, while in the quest for ever faster and more precise measurement of vastly smaller forces, masses, as well as other quantities, mechanical tools have now been reduced to well below one micrometer in at least two of the three physical dimensions. Even at sub-wavelength dimensions, light remains a competitive and, in many cases, superior choice for the mechanical signal detection, for both fundamental and engineering reasons. Optomechanical interactions are strongly enhanced by high quality factor nanophotonic resonators, localizing photons and extending interaction times, making possible quantum-limited nanoscale motion readout at modest optical power and with low power dissipation. Si photonics technology transforms these devices into fiber-connectorized, compact, robust, stable and practical sensors requiring no optical alignment. Their superior precision and bandwidth have recently been used to advance Atomic Force Microscopy, replacing traditional microscale cantilevers and their laser-readout optics. Similar, integrated cavity-optomechanical detection has been employed to characterize nanoscale stress-controlled SiN tuning fork resonators which exhibit some of the highest measured fQ products and show great practical promise for precise, high bandwidth, and high bias stability on-chip motion measurement. Integration of gap-plasmonic resonators into nanomechanical systems achieves not only precise but truly local motion measurement, confined to a 100 nm scale footprint, capable of spatially distinguishing between NEMS mechanical modes. Broadband and lossy nature of plasmonics allows the use of white light for motion readout and enables very compact thermo-optically driven plasmomechanical oscillators. These examples illustrate the significant, yet largely unexplored, technological potential of highly integrated transducers combining Si photonics, MEMS, NEMS, cavity-optomechanics and plasmonics.