PRISM Seminar Series – Fall 2009

Casimir force and of near-field radiative heat transfer at the MEMS and AFM scales

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Abstract: Near-field force and energy exchange between two objects due to quantum and thermal induced electrodynamic fluctuations give rise to interesting phenomena such as Casimir/van der Waals forces and thermal radiative transfer far exceeding Planck theory of blackbody radiation. While quantum fluctuations, related to zero point energy, yields to the formulation of the Casimir/van der Waals force, near-field radiative heat transfer is only due to classical thermodynamics charge fluctuations. Although significant progress has been made in the past in the precise measurement of the Casimir force, a detailed quantitative comparison between theory and experiments in the sub-micron regime was still lacking when speaking about heat transfer. I shall first make a simple introduction on how the charge fluctuations give rises to these effects that are nowadays most effectively detected using MEMS or AFM technologies. This will lead me to question the relevance of these effects in the use of MEMS. After description of our quantitative measurement of the Casimir force and comparison with theory, I shall report on our experimental data on the thermal flux spatial dependence. Theory based on the Derjaguin approximation, successfully used here for the first time to describe radiative heat transfer from the far field to the near field regimes, reproduces the measured dependence.

Bio: Joël Chevrier (49) is Professor of Physics at the University Joseph Fourier (UJF) of Grenoble. He is heading the research program in Nanomechanics at the Institut Néel CNRS and at the European synchrotron, ESRF. His original background is in Solid State Physics, (superconductivity, silicon MBE, quasicrystals). His current research is based on instrument developments in Scanning Probe Microscopy. He deals with measurements and controls of interactions between nanobjects (Casimir Force, thermal transfer at nanoscale, combination of X ray and AFM at the synchrotron). This is at the substrate of his collaboration with Profs. Arvind Raman and Ron Reifenberger. Together with the “Informatique and Creation Artistique” laboratory headed by Annie Luciani, his group develops the program Nanoworker that aims at the combination of mechanical sensors and actuators operating at nanoscale with Virtual Reality interfaces. Such a program is at the origin of his collaboration with Prof. Hong Tan at Purdue University. Joël Chevrier is Research Vice-President of the University Joseph Fourier in charge of Engineering and Physical Sciences. He is teaching courses on Nanophysics, Sensors and Actuators, Scanning Probe Microcopy.