Technion-Israel Institute of Technology
Faculty of Mechanical Engineering

הטכניון-מכון טכנולוגי לישראל
הפקולטה להנדסת מכונות

סמינריון

הנך מוזמן/ת להרצאה סמינריונית של הפקולטה להנדסת מכונות, שתתקיים ביום ד' 15.03.17 (יז' באדר, תשע"ז), בניין דן-קאהן, קומה 0, אודיטוריום 1 , 13:30.

ירצה: אייל הולנדר

מנחה: פרופ' עודד גוטליב

על הנושא:

Self-excited Oscillations, Bifurcations and Chaos in Nonlinear Optomechanical Thermo-Visco-Elastic Panel Resonators

The seminar will be given in Hebrew

להלן תקציר ההרצאה:

Nonlinear macro-, micro- and nano- optomechanical resonators (OMR's) have been extensively studied in recent years due to their promising potential for non-intrusive sensing, quantum computing and optical tweezing. In a free-space OMR, a thin mechanical panel is coupled to an optical cavity through Lorentz forces and bolometric heating. In the absence of external modulation, the interaction with these forces can lead to self-excitation of the resonator, in which a response to a continuous wave laser culminates with periodic limit-cycle oscillations beyond an equilibrium state stability threshold. These oscillations can in-turn lose their orbital stability to period-doubled, quasiperiodic and nonstationary dynamics. Characterizing these thresholds, among other effects, is crucial in explaining observed phenomena such as hysteresis, mode-hopping and optical cooling. To date, the dynamics of OMR's have been described by nonlinear lumped-mass models that do not incorporate the spatiotemporal complexity of the coupled thermo-visco-elastic and electromagnetic (EM) fields. In addition, most researches have focused on cases in which only one of the forces (i.e. bolometric or radiation effects) is active and in the close vicinity of an optical resonance.

Thus, we derive a continuum mechanics-based nonlinear thermo-visco-elastic model for a thin panel under the influence of an EM field. The latter is constructed by constraining the light-structure interaction to first order scattering phenomenon (classical interpretation) modelled as a spatiotemporal perturbation around a time-harmonic field. We employ a Galerkin procedure on the resultant fields and replace them with their modal counterparts. It is shown that for a range of parameters the combined and separate effects of bolometric and radiation stresses induce a spatially-dependent complex dynamical response where Hopf bifurcations evolve into periodic, quasiperiodic and chaotic-like strange attractors that are sensitive to initial conditions. In regions where coexisting solutions are found, homoclinic connections ensue co-dimension two Bogdanov-Takens and Zero-Hopf bifurcations. We show that for a range of control parameters a homoclinic loop of a saddle-focus elicit a global Shilnikov bifurcation which culminates with a distinct period-doubling route to chaos. We investigate a limiting case of an adiabatic EM field in which a bolometric planar beam model is used to validate experimental results, including hysteresis effects and mechanical mode-switching that can lead to quasiperiodic breakdown and homoclinic chaos.

בברכה,

פרופ"מ שמואל אוסובסקי
מרכז הסמינרים