הטכניון – מכון טכנולוגי לישראל

הפקולטה להנדסת מכונות

סמינריון

הנך מוזמן/ת להרצאה סמינריונית של הפקולטה להנדסת מכונות, שתתקיים ביום ה' 2.06.16
(כה' באייר, תשע"ו), בבניין דן-קאהן, קומה 0, אודיטוריום 1, 14:30.

תרצה: סלין דורוק

מנחה: פרופ' אלכס אורון

על הנושא:

Nonlinear Dynamics of Thin Liquid Films on Vibrating Surfaces

The seminar will be given in English

להלן תקציר ההרצאה:

The dynamics and stability of thin liquid films have attracted scientists, influenced several related research topics and lead to considerable developments in theoretical investigations, numerical studies and experimental work over decades. The reason that makes this subject an alluring research area is due to its significant role in our daily lives as well as its essential applications in technology and nano-science. Among the wide range of phenomena and applications where thin film flows occur, it is worth to mention just a few: in engineering, liquid spreading, dewetting, falling films, coating of static and rotating substrates, flows driven by surfactants, thermocapillary and electromagnetic forces, condensers and heat exchangers; in biology, linings of airways and mammalian lungs, tear films in human eyes and many others.

The goal of the present research is to analyze the nonlinear dynamics of thin liquid films on horizontally vibrating surfaces of several topological forms, in the high-frequency limit. It is well known that external forcing may lead to dramatic changes in the dynamics of physical systems, and the best example for this is Kapitza's inverted pendulum where the unstable equilibrium of an unforced pendulum may be stabilized when the system is forced. Thus, high-frequency forcing of the substrate is a good candidate to examine in terms of investigation of possibilities to manipulate the evolution of liquid film coatings.

The fluid-mechanics problems at hand for planar, corrugated and cylindrical geometries of the substrate subjected to high-frequency forcing are governed by the incompressible Navier-Stokes equations along with the appropriate boundary conditions. The method used to tackle these complicated problems is based on the long-wave asymptotics and on incorporating the effect of high-frequency forcing via two relevant time scales, namely the slow time scale associated with the film dynamics and the fast one related to forcing itself. The relevant fields to be determined such as the flow velocity, pressure and film-interface location are split into their averaged (slow) and pulsating (fast) components and by averaging the equations over the fast time scale, the entire problem is decomposed into two separate problems. Solution of these leads to a single nonlinear partial differential equation of the evolution type serving as a framework for analytical and numerical investigation of the spatiotemporal dynamics of the film. In the problem of a cylindrical substrate, where a base state is known, linear and weakly nonlinear analyses are both carried out. In the problem of a periodic corrugated wall where base states are impossible to determine analytically, the study of their stability is performed via numerical investigation. Stability of the emerging steady flows is studied using the Floquet analysis in the framework of the corresponding time-independent problem, low-order reduced sets of equations for the time-dependent dynamics and full numerical solutions.

We conclude that high-frequency forcing may be utilized to control the stability properties and to alter the dynamics of the investigated systems consisting of liquid films on flat planar, corrugated and cylindrical surfaces with respect to the unforced ones.

בברכה,

פרופ'/מ אמיר גת

מרכז הסמינרים