PIMS / AMI Seminar

Friday, December 7, 2012
3:00 p.m.
CAB 657

"Weak ellipticity: why lubrication approximation works better than expected and how disturbances can propagate upstream in supersonic flows?"

Rouslan Krechetnikov
Department of Mechanical Engineering
University of California at Santa Barbara

Abstract

In this talk, which is a combination of theory and experiment, we will introduce the notion of weak ellipticity -- a non-standard characteristic property of certain PDE systems. As physical illustrations and motivations, we will discuss two long-standing physical problems. The first concerns the Lighthill problem of propagation of disturbances in viscous supersonic flows. Unlike previous results for linearized systems we deduce a condition determining nonlinear characteristic surfaces, which is exact and therefore allows both qualitative and quantitative studies of the speed of propagation as a function of various physical phenomena. These include negative and adverse pressure gradients, and effects of wall cooling and suction–blowing, which are studied as an illustration of the general theory. The second problem resolves the well-known paradox of lubrication analyses, which are always developed under the assumption of a unidirectional flow and thus are believed to be of parabolic character, but turn out to be able of capturing flow topologies around stagnation points, contact lines, and flows over edges, all of which normally require elliptic operators to be accounted for. The discovered weak ellipticity property of the lubrication analysis explains the empirically observed over performance of lubrication approximations. This also allowed us to resolve the long-standing controversy of the origin of film thickening phenomenon in the classical Landau–Levich problem of dip-coating both theoretically and experimentally.

Refreshments will be served in CAB 649 at 2:30 p.m.