

PHYSICAL MATHEMATICS SEMINAR

Mobility Laws for Fluid Flow over Arbitrarily Patterned Surfaces

KENNETH KAMRIN

Massachusetts Institute of Technology

ABSTRACT:

Driven primarily by advances in microfluidics, the usage of surface texture to influence the motion of small-scale fluid flow has become a significant topic of research. To represent flow over surfaces with anisotropic height fluctuations and/or fluctuations in hydrophobicity, it can be very complicated to implement the exact boundary conditions along the actual fluctuating surface. Instead one desires an “effective boundary condition”, which can be applied on the mean surface and sufficiently mimics the far-field effects of the actual surface. These conditions are typically tensorial, relating the apparent slip velocity as seen far from the surface to the applied shear stress that induces it. In this talk, we derive a list of highly general analytical results that describe/derive this mobility tensor from the actual surface patterning assuming the low-Reynolds limit. Specifically: (1) We shall prove that mobility tensors are always symmetric, (2) In the case of flat surfaces with fluctuating hydrophobicity, a straightforward albeit large linear system is presented whose solution gives the mobility tensor. We derive a set of complementary theorems and produce an exact solution for a particular case. (3) A perturbation analysis shall be performed that gives a second-order slip tensor formula (with error bounds) for surfaces with both height and hydrophobic fluctuations, (4) A set of optimization and statistical analyses will be conducted based on the perturbation theory result.

TUESDAY, DECEMBER 6, 2011

2:30 PM

Building 2, Room 105

*Reception at 3:30 PM in Building 2, Room 290
(Math Dept. Common Room)*

<http://math.mit.edu/pms>



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