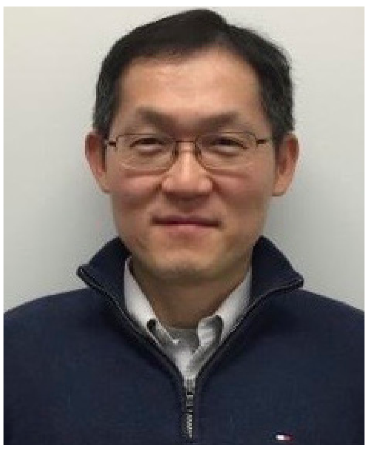
UNIVERSITY OF MARYLAND

THE BURGERS PROGRAM FOR FLUID DYNAMICS
THE FLUID DYNAMICS REVIEWS SEMINAR SERIES

SPREADING OF A DROPLET ON A SOLID SUBSTRATE AND AN IMMISCIBLE LIQUID FILM



Friday, April 28, 2023 | 11 am

DeWalt Seminar Room
2164 Glenn L. Martin Hall

Speaker

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ABSTRACT

When a liquid drop makes contact with a solid surface or an immiscible liquid film, the contact line moves until the gas/liquid/solid (or liquid film) system reaches the equilibrium state. This process is known as spreading. The spreading dynamics is relevant to many natural and engineering processes ranging from pollutant oil-wetting fish scales and hydrophobic feet of insects to inkjet/3D printing, coating, and water-oil mixtures in oil recovery. Despite the apparent simplicity of a spreading liquid drop, the evolution of the drop is difficult to investigate analytically as the classical continuum hydrodynamic description of the contact line motion under the usual no slip condition at the solid surface leads to a non-integrable stress singularity. The focus of this presentation is on determining the influence of mass transfer across the interface through condensation on the early time dynamics of inertial spreading and comparing the numerical results reported in this work to the experimental results. As all liquids are volatile to a certain extent, it is expected that phase change can aid the contact line motion with the no slip boundary condition applied at the solid boundary. Here use is made of Kelvin's equation that is naturally incorporated into the phase field lattice Boltzmann method (LBM) framework, giving the dependence of the equilibrium vapor pressure of a liquid on the curvature of its exposed surface. When an aqueous drop contacts an oil film, it displays complex interfacial dynamics based on the spreading factor. When the spreading factor is positive, upon contact, the oil spreads onto the drop's liquid/gas interface, first forming a liquid bridge whose curvature drives an apparent drop spreading motion and later engulfs the drop. Inertially and viscously limited dynamics are explored numerially using the Ohnesorge number Oh and the ratio between the film height H and the initial drop radius R.

BIO

Dr. Lee is an associate professor in the Department of Mechanical Engineering at City University of New York (CUNY) - City College campus. He is a core faculty member of the CUNY Energy Institute. He received his B.S. and M.S. degrees from the Seoul National University, and Ph.D. degree in Mechanical Engineering from the University of Iowa. Dr. Lee is the recipient of the 2005 J.H. Wilkinson Fellowship from the Mathematics and Computer Science Division at the Argonne National Laboratory. He is currently serving as an associate editor for Computers & Fluids. His research expertise is in the areas of multiphase/multiscale computational fluid dynamics and high-order methods for the lattice Boltzmann equation.

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