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PREFACE: TWO PHASE SYSTEMS

Two-phase flows are encountered in many practical applications and are generally characterized by the presence of deforming interfaces between two immiscible fluid phases. Coupling between the evolution of these interfaces and fluid flow in the two phases can lead to remarkably rich dynamics not seen in single-phase systems under similar conditions. Notable examples of such dynamics include the formation of waves on the surface of a liquid film, mass transfer due to evaporation or condensation, breakup of liquid jets, formation of bubbly flows by air entrainment, and many other phenomena. The richness of the flow patterns translates into many possibilities for optimizing the working parameters for particular applications; for example, in achieving the highest possible heat transfer coefficients in two-phase cooling systems. Such systems are, or can be, used for thermal management on a wide variety of length scales, from the large scales of power plants and spacecraftto the small scales of laptop computers and cell phones. Research on two-phase flows is also important for flotation and separation technologies, enhanced oil recovery, as well as chemical synthesis.

A brief look at the papers in the present issue clearly shows both geographic diversity and a wide range of approaches characteristic of the two-phase flow community. The papers come from research groups in China, Japan, Mexico, and Russia. Novel results are obtained for several different flow configurations using theoretical, numerical, and experimental methods.

A configuration of particular importance for theoretical work on two-phase flows is that of a thin liquid film on a solid substrate. The description of the viscous flow in the liquid film can be drastically simplified by taking advantage of the small value of the ratio of the film thickness to the length scale in the direction along the substrate. Recent successful applications of this approach to films flowing down inclined solid surfaces are discussed in the comprehensive review article of Davalos-Orozco. Linear stability criteria and nonlinear evolution equations are reviewed for both isothermal and non-isothermal thin-film flows. It is especially important to emphasize that some very recent results are included, which were not covered by previous reviews on thin films. In addition to the case of a flat solid substrate, Davalos-Orozco provides an overview of theoretical models of flows down both isothermal and heated cylindrical surfaces.

The important topic of liquid film flows on curved substrates is also addressed in two other papers in the present issue. Alekseenko et al. use high-speed laser-induced fluorescence to investigate interfacial waves in a liquid film on the inner surface of a vertical cylindrical pipe. Concurrent gas flow through the pipe affects the film dynamics through the shear-stress balance at the gas–liquid interface. Two types of waves are recorded: fast primary waves and slow secondary waves generated at the back slopes of the primary waves. Marchuk et al. use a combination of numerical and experimental methods to investigate condensation inside a circular tube. Flow in the condensing film is driven by a combination of gravity and shear stress from the pressure-driven flow in the vapor phase. Good agreement is found between the numerical and experimental results.

Finally, we note that for two-phase flows involving jets and sprays, there is no solid substrate and the shapes of two-dimensional deforming fluid interfaces can be very complicated. Examples of such flows are also discussed in the present issue. Du et al. use experimental methods to study the breakup of a liquid jet flowing into a low-pressure environment for different temperatures. Formation of a cloud of droplets is detected at the final stages of jet breakup. Tanaka et al. use electrostatically levitated droplets to develop a novel approach to measurement of liquid viscosity.

The team of Guest Editors is grateful to all of the authors who submitted their high-quality research articles to our special issue and to the referees whose thoughtful and timely reviews helped us throughout the selection process. We hope that the present issue will be useful for our community and will stimulate further progress in the rapidly developing field of two-phase flows.

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