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The Marangoni Effect: From Macroscopic to Microscopic Perspective

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Date: Wednesday, June 25, 2025 15:00-16:00
Venue: Faculty of Engineering Bldg. 2, Room 31A

Abtract: The Marangoni phenomenon, first observed in the so-called "tears of wine" by physicist James Thomson in 1855, has fascinated scientists for over a century. It has been extensively studied and applied to diverse fields, including material migration, mixing, coating, and cleaning. At its core, the Marangoni effect is driven by surface tension gradients that induce fluid motion along interfaces, making it a fundamental mechanism in interfacial phenomena.

In this talk, we investigate the intricate dynamics of solutal Marangoni instabilities in two representative systems: a fully soluble volatile liquid droplet on a liquid surface and an evaporating binary mixture droplet. These seemingly simple systems exhibit complex interfacial turbulence and spontaneous agitation, challenging the predictions of traditional fluid mechanics.

To unravel these intriguing behaviors, we employed various experimental techniques such as background-oriented schlieren imaging, particle tracking velocimetry (PTV), and micro-particle image velocimetry (μPIV). By integrating these methods, we achieved unprecedented insights into the interplay between continuum-scale fluid mechanics and molecular-scale surface tension forces.

Our findings reveal the limitations of conventional continuum theories in capturing the full complexity of Marangoni-driven flows. By bridging the gap between macroscopic and microscopic scales, this research advances our understanding of interfacial phenomena and paves the way for innovative applications across various disciplines, from materials science to biomedical engineering.

Prof. Hyoungsoo Kim
Department of Mechanical Engineering, KAIST, South Korea

Bio: Prof. Hyoungsoo Kim is a tenured associate professor in the Department of Mechanical Engineering at the Korea Advanced Institute of Science and Technology (KAIST). He earned his PhD in Mechanical Engineering from Delft University of Technology (TU Delft) in 2013. Following his doctoral studies, he joined Prof. Howard Stone's group at Princeton University as a Postdoctoral Researcher and later as an Associate Research Scientist from 2013 to 2016.

In 2022, during his sabbatical year, Prof. Kim joined Prof. David Weitz's group at Harvard University as a visiting scholar, further broadening his research expertise. Currently, he leads the Active Plasma Control Research Lab at KAIST. His research spans diverse areas, including the development of advanced flow visualization techniques, the study of soft matter physics,
coating and printing technologies, hydrodynamic instabilities, and interfacial flow phenomena.

Prof. Kim's contributions to the field have been recognized with several prestigious awards, such as the Kasan Award in Fluids Engineering (2024) from the Korean Society of Mechanical Engineers (KSME), the Technology Innovation Award (2022), the Fusion Research Award (2021), and the Songam Future Scholar for Excellent Research (2021)from KAIST. Additionally, he received the Young Engineering Award (2018) from the Korea Society of Visualization.

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