筑波大学
University of Tsukuba

EME International Seminar Series

Simulations of Evaporating Droplets in Turbulence

Luca Brandt
Professor
Department of Engineering Mechanics, KTH, Sweden and
Department of Energy and Process Engineering, NTNU, Norway

Abstract:

Understanding droplet evaporation plays a crucial role in many contexts, from industrial applications (e.g., spray combustion, cooling towers), environmental flows (e.g., oceanic sprays and cloud formations), to the biomedical sector (e.g., spreading of infectious diseases). Numerical simulations are vital to advancing the scientific understanding of these flows, as they can complement experimental research and provide detailed physical insight and predictive capability. In this talk, I will first introduce a general mathematical framework able to describe evaporation in a weakly compressible formulation. The proposed methodology allows relaxing the assumption of constant thermophysical properties while effectively filtering the acoustics effects and the associated stringent numerical time-step restrictions. Next, I will present results from interface-resolved simulations of finite-size evaporating droplets in weakly compressible homogeneous shear turbulence, varying the droplet size and the strength of the surface tension forces. In particular, I will show that the ratio between the actual evaporation rate in turbulence and the one computed in stagnant conditions is always much higher than one for weakly deformable droplets, even at high temperatures. I will examine the correlation between the local evaporation rate and the local interfacial curvature, showing that there is a positive correlation between the two quantities only when evaporation is in a convection-dominated regime. Finally, I will comment on the effect of the liquid volume fraction on the evaporation rate of a droplet suspensions.

References:

- *Finite-size evaporating droplets in weakly compressible homogeneous shear turbulence N. Scapin, F. Dalla Barba, G. Lupo, M. E. Rosti, C. Duwig and L. Brandt, J. Fluid Mech., 934, A15, 2022*
- *An interface capturing method for liquid-gas flows at low-Mach number F. Dalla Barba, N. Scapin, A. D. Demou, M. E. Rosti, F. Picano, and L. Brandt, Computers and Fluids, 216, 104789, 2021*
- *A volume-of-fluid method for interface-resolved simulations of phase-changing two-fluid flows N. Scapin, P. Costa and L. Brandt, Journal of Computational Physics, 407, 109251, 2020.*

Bio:

Dr. Luca Brandt is professor in Fluid Mechanics at the Royal Institute of Technology (KTH), Stockholm, Sweden since 2012 and at the Department of Energy and Process Engineering, NTNU, Trondheim, Norway since 2021. He received a Masters in Mechanical Engineering from University of Rome, La Sapienza in 1997, and PhD in Fluid Mechanics at KTH in 2003. Before joining KTH as assistant professor he spent several months at Ecole Polytechnique, Palaiseau, France and at the University of Bologna, Italy. Luca's research interests are in the general area of multiphase turbulence, particle laden flows, heat and mass transfer, low-Reynolds-number flows and complex fluids, hydrodynamic instabilities and flow control, with focus on the development of theoretical models and high-fidelity numerical simulations. He has more than 180 peer-reviewed journal papers including 1 Annual Review Fluid Mechanics in 2022. He was the recipient of an ERC consolidator grant to study particle suspensions in 2013 and of the "outstanding young researcher" award from the Swedish Research Council in 2014. He had been awarded the G. Gustafsson prize in 2005 and the position as outstanding researcher in Mechanics by the Swedish Research Council in 2008. Luca has served the community organizing several workshops and summer schools and is associated editor of the European Journal of Mechanics/B and of MECCANICA.

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Online (Microsoft Teams, code: z2y60pz)