Title: Splashing, coalescing and drying of droplets

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Outline (4 lectures, 45minutes each):

Lecture 1: I will first introduce the general background of liquid splashing due to drop-substrate impacts. Then I will focus on our surprising discovery about the important role of air in this ubiquitous phenomenon: on a smooth surface there will be no splashing when the surrounding air is gotten rid of. A qualitative model relating the destabilizing effect from air and the stabilizing effect from the surface tension will be illustrated. A brief summary of splashing on rough and textured surfaces will also be included [1-3].

Lecture 2: I will illustrate the detailed behaviors of air in the drop impact and splashing. Two topics will be covered: (1) the behavior of air pocket trapped at the center of impact, and (2) the role of air directly beneath the moving contact line. I will demonstrating the interesting results that the trapped air at impact center has a pressure as high as a few ATM; while the thin air film under the moving contact line is responsible for liquid splashing [4].

Lecture 3: I will lecture on the phenomenon opposite to the droplets breakup: their coalescence. After a general introduction of coalescence, I will focus on our research on the merging of special droplets: the Pickering emulsion droplets which are droplets coated by solid particles. I will show the crucial role of the solid particles, which causes two distinct types of coalescence: the normal and the abnormal coalescence [5-7].

Lecture 4: I will talk about the drying of complex-fluid droplets, which reveals the essential physics of drying in porous medium. For systems containing solid particles, the Laplace pressure introduces a strong flow from large to small pores; while for more complex systems containing both solid particles and emulsion droplets, the Laplace pressure collapses large droplets and produces “black holes” in the porous medium. These findings are crucial for understanding the drying in porous media and may lead to novel materials such as hierarchical structures and smart paints [8, 9].

References:

[1] “Drop Splashing on a Dry Smooth Surface,” L. Xu, W. W. Zhang and S. R. Nagel, *Phys. Rev. Lett.* **94**, 184505, 2005.

[2] “Splashing of liquids: Interplay of surface roughness with surrounding gas” L. Xu, L. Barcos and S. R. Nagel, *Phys. Rev. E*, **76**, 066311, 2007.

[3] “Liquid drop splashing on smooth, rough, and textured surfaces”, L. Xu, *Phys. Rev. E*, **75**, 056316, 2007.

[4] “Compressible air entrapment in high-speed drop impacts on solid surfaces”, Y. Liu, P. Tan and L. Xu, *J. Fluid Mech*. **716**, R9, 2013.

[5] “Non-coalescence of oppositely charged drops”, W. D. Ristenpart, J. C. Bird, A. Belmonte, F. Dollar, and H. A. Stone, *Nature* (London) **461**, 377, 2009.

[6]”Critical angle for electrically driven coalescence of two conical droplets”, J. C. Bird, W. D. Ristenpart, A. Belmonte, and H. A. Stone, *Phys. Rev. Lett.* **103**, 164502, 2009

[7] “Coalescence of Pickering Emulsion Droplets Induced by an Electric Field”, G. Chen, P. Tan, S. Chen, J. Huang, W. Wen and L. Xu, *Phys. Rev. Lett*. **110**, 064502, 2013.

[8] “Dynamics of drying in 3D porous media”, **L. Xu**, S. Davis, A. Schofield and D. Weitz, *Phys. Rev. Lett.*, **101**, 094502, 2008.

[9] “Drying of complex suspensions”, **L. Xu**, A. Berges, P. Lu, A. Studart, H. Oki, A. Schofield, S. Davis and D. Weitz, *Phys. Rev. Lett.*, **104**, 128303, 2010