LadHyX Seminar – September 26th, 10:45

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Coalescence of slender structures removed from a liquid bath and liquid transport by rigid brushes

We study the coalescence between two slender structures withdrawn from a liquid bath. When partially immersed, the structures interact with each other through the capillary force induced by their menisci whose shape changes with the retraction speed. As the structures are removed from the bath, their dry length increases, and they become easier to bend until the capillary force is strong enough to trigger contact. Surprisingly, the structures snap to contact from a finite distance at a critical dry length. The transition to coalescence is thus subcritical and exhibits a large hysteresis loop between two stable states. An analytical coalescence criterion is derived when the structures (rods or lamellae) are withdrawn quasi-statically from the bath with a good agreement with experimental data. In the case of two rods removed at finite velocity, the size of the menisci around them grows with the retraction speed and the capillary interaction increases. The rods coalesce then at a shorter dry length. We characterize the menisci growth as a function of the capillary number and show that the interaction between the structures is given by the static interaction with an effective surface tension increasing with the capillary number. Finally, we study the liquid transport by brushes composed of an equilateral triangular array of rigid pillars partially immersed in a liquid bath and withdrawn at a finite speed. We derive a partial differential equation describing the evolution of air-liquid interface inside the brush during the retraction and compare its predictions with experimental data. We show that, for given retraction speed and immersion depth, there exists an optimal porosity maximizing the amount of liquid captured by the brush.