PHYSICAL MATHEMATICS SEMINAR

COALESCENCE OF LIQUID DROPS: PHYSICS, CHALLENGES AND BOUNCELETS!

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ABSTRACT:

The cascades of partial-coalescence of a drop on a planar liquid surface can be observed if one carefully deposits a large drop of water on a water/air interface with very low impact velocity. This study consisted of placing drops of various sizes and physical properties on a planar interface with the aid of a high-speed digital camera. The focus of this research is study the time of coalescence and the size of the secondary drop that formed after coalescence had finished. Results of the experiments showed clear patterns with respect to inertial and viscous terms. Dimensional analysis indicated that the Ohnesorge number, Oh, had a strong influence on the behavior of drop coalescence. The ratio of secondary drop radius to primary drop radius was calculated to be approximately constant when Oh was much smaller than unity. However, as Oh approached unity from the lower bound, the value of r_i decayed. No secondary drop was observed when Oh was greater than unity. Normalized coalescence times confirmed this trend by being properly scaled with inertial time scales for small Oh and preferring viscous time scales when Oh was greater than unity. An interesting feature of this cascade is the bouncing of the secondary drop on the planar surface, which we called Bouncelet. As the secondary drops get smaller, they bounce higher in the air. We show that the capillary force is the main driving force for this phenomenon. By using high-speed video, it is revealed that the capillary force at the pinch off pulls the drop to the planar interface. The drop then bounces on the interface and moves upward until it reaches the maximum height. We develop a theory that includes the capillary and gravitational forces and predicts the maximum height of the bouncing drop. We show that our theory matches well with the experimental results for several fluids such as water, methanol and silicone oil.

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