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Scaling Analysis of the Contact Line and Capillary Interaction Induced by a Floating Tilted Cylinder

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Abstract : When a floating tilted cylinder pierces a fluid interface, the fulfilment of constant-contact-angle condition along the cylinder results in shift, stretch and distortion of the contact line, thus leading to a capillary interaction. We perform an investigation of the scaling dependence of tilt angle, contact angle, and cylinder radius on the contact line profile and the corresponding capillary interaction by numerical simulation and experiment. Characterized by three characteristic parameters respectively, the dependences for each deformation mode are systematically analyzed. Both the experiment and simulation reveals an invariant structure that is independent of contact angle and radius to characterize the stretch of the contact line for every tilted case. Based on this observation, we then propose a general capillary force scaling law to incredibly grasp all the simulated results, by simply approximating the contact line profile as tilted ellipse.

Keywords : gas-liquid/liquid-fluid interface, colloidal particle, contact line shape, capillary interaction, surface evolver (SE)
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