title: Dynamics of droplets on flat substrates: Lattice Boltzmann modeling versus simple analytic models

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Recently, controlling droplet motion have attracted considerable interests due to their promising applications ranging from microfluidic devices to fuel cells and inkjet printing [1-4]. In this contribution, we concentrate on the steady state motion of cylindrical drops under the action of body force on a perfectly flat substrate. Despite the apparent simplicity of the problem, several issues, such as dependence of the center-of-mass velocity and the dissipation loss on the material parameters and external forcing as well as the role of droplet deformation are still not fully understood [5]. Driving a simple analytic relation, we show that as long as droplet deformation is negligible, droplet's center-of-mass velocity linearly scales with force density and is proportional to the square of the droplet radius. A variation of viscosity, on the other hand, has no influence on the shape of droplet. Consequently, center-of-mass velocity is directly proportional to the inverse of viscosity regardless of the deformation state of droplet. We employ a free-energy based lattice Boltzmann model [6-8] to investigate all these issues. In addition, a detailed study of the local dissipation loss inside droplet is also provided. A result of these investigations is that dissipation mainly occurs within a region below the droplet's center-of-mass. Using the latter observation, we propose a simple analytic expression accounting for the dependence of droplet velocity on the equilibrium contact angle. Results of computer simulations confirm the validity of this simple model [9].

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