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Hysteretic and Chaotic Dynamics of Viscous Drops in Creeping Flows with Rotation[1] YUAN-NAN YOUNG, Depatment of Mathematical Sciences, New Jersey Institute of Technology, JERZY BLAWZDZIEWICZ, Department of Mechanical Engineering, Yale University, VITTORIO CRISTINI, University of Texas, Houston, ROY GOODMAN — It has been shown in our previous publication (Blawzdziewicz et al 2003) that high-viscosity drops in two dimensional linear creeping flows with a nonzero vorticity component may have two stable stationary states. One state corresponds to a nearly spherical, compact drop stabilized primarily by rotation, and the other to an elongated drop stabilized primarily by capillary forces. Here we explore consequences of the drop bistability for the dynamics of highly viscous drops. Using both boundary-integral simulations and small-deformation theory we show that a quasi-static change of the flow vorticity gives rise to a hysteretic response of the drop shape, with rapid changes between the compact and elongated solutions at critical values of the vorticity. In flows with sinusoidal temporal variation of the vorticity we find chaotic drop dynamics in response to the periodic forcing. A cascade of period-doubling bifurcations is found to be directly responsible for the transition to chaos. In random flows we obtain a bimodal drop- length distribution. Some analogies with the dynamics of macromolecules and vesicles are pointed out.

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