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Nonlinear electrohydrodynamics of a viscous droplet PAUL SALIPANTE, PETIA VLAHOVSKA, Brown University — A classic result due to G.I.Taylor is that a drop placed in a uniform electric field adopts a prolate or oblate spheroidal shape, the flow and shape being axisymmetrically aligned with the applied field. We report an instability and transition to a nonaxisymmetric rotational flow in strong fields, similar to the rotation of solid dielectric spheres observed by Quincke in the 19th century. Our experiments reveal novel droplet behaviors such as tumbling, oscillations and chaotic dynamics even under creeping flow conditions. A phase diagram demonstrates the dependence of these behaviors on drop size, viscosity ratio and electric field strength. The theoretical model, which includes anisotropy in the polarization relaxation, elucidates the interplay of interface deformation and charging as the source of the rich nonlinear dynamics.

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