Abstract Submitted
for the DFD13 Meeting of
The American Physical Society

Deformation of leaky-dielectric fluid globules under strong electric fields: Boundary layers and jets at large Reynolds numbers ORY SCHNITZER, ITZCHAK FRANKEL, EHUD YARIV, Technion - Israel Institue of Technology — In Taylor's theory of electrohydrodynamic drop deformation (Proc. R. Soc. Lond. A, vol. 291, 1966, pp. 159-166), inertia is neglected at the outset, resulting in fluid velocity that scales as the square of the applied-field magnitude. For large drops, with increasing field strength the Reynolds number predicted by this scaling may actually become large, suggesting the need for a complementary large-Reynolds-number investigation. Balancing viscous stresses and electrical shear forces in this limit reveals a different velocity scaling, with the 4/3-power of the applied-field magnitude. We focus here on the flow over a gas bubble. It is essentially confined to two boundary layers propagating from the poles to the equator, where they collide to form a radial jet. At leading order in the Capillary number, the bubble deforms due to (i) Maxwell stresses; (ii) the hydrodynamic boundary-layer pressure associated with centripetal acceleration; and (iii) the intense pressure distribution acting over the narrow equatorial deflection zone, appearing as a concentrated load. Remarkably, the unique flow topology and associated scalings allow to obtain a closed-form expression for this deformation through application of integral mass and momentum balances. On the bubble scale, the concentrated pressure load is manifested in the appearance of a non-smooth equatorial dimple.

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Date submitted: 23 Jul 2013 Electronic form version 1.4