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3D Mixing Inside a Neutrally Buoyant Drop Driven by Electrohydrodynamic Flows XIUMEI XU, G.M. HOMSY, University of California, Santa Barbara — For a neutrally buoyant drop subjected to a uniform electric field, the internal flow is the well-known Taylor circulation. In Phys. Fluids 19 013102 (2007), we theoretically studied three dimensional mixing by periodically switching a uniform electric field through an angle α. Periodically switching the field is equivalent to periodically changing the symmetry axis of the Taylor circulation. For $\alpha = 0.5\pi$, there is no chaotic mixing because the common heteroclinic trajectories form the separatrix of the flow. For other switching angles, chaotic advection is generated due to perturbations of the heteroclinic trajectory. Experimental investigations of mixing were carried out using a nearly isopycnic silicone oil/castor oil system. For $\alpha = 0.5\pi$, our experiments show the existence of symmetry planes. In addition, two blobs of particles are observed to maintain almost invariant shapes for very long time, indicating the absence of chaotic mixing, as predicted by the theory. For other switching angles, experiments show the penetration of symmetry planes by tracer particles. However it is difficult to draw definitive conclusions regarding chaotic mixing because of charge relaxation, long initial transients and drop translation effects.

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