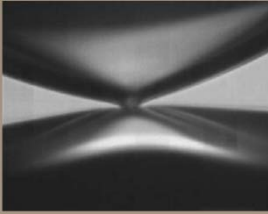


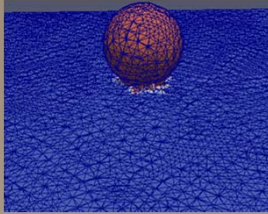
Exceptional service in the national interest



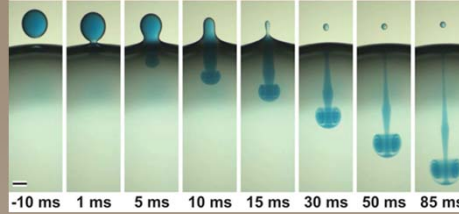
A bridge between oppositely charged drops: repulsion follows (Ristenpart, 2009)



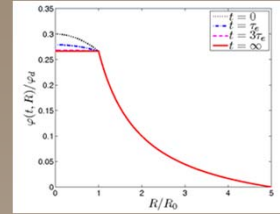
A FEM mesh simulating a coalescing drop.



A charged drop injected with dye undergoes partial coalescence (Hamlin, et. al. 2012)



Theoretical solution of charge decay on a radially symmetric conducting drop.



Toward Simulations of Charged Coalescing Drops

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(expected graduation June 2014)

Abstract

We are working toward the simulation of multiphase fluids moving under the influence of electric forces, with the intention of examining the coalescence of charged drops. To date, we have formulated a system of governing equations; reduced them to simpler form using dimensional analysis; analytically solved a simple test case; developed two numerical methods for studying multiphase flow; and begun work on extending these methods to include electric forces, using the test case as a guide.

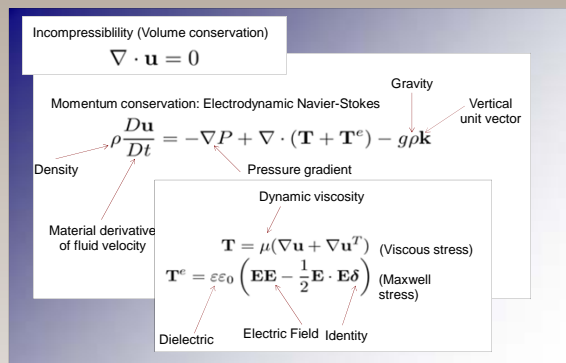
Significance

It has recently been discovered that charged drops in the presence of an electric field fail to coalesce above a critical field strength (Ristenpart, et. al. 2009). Because electric forces are often used to move suspended drops understanding this behavior may allow us to improve industrial processes which rely on this mechanism.

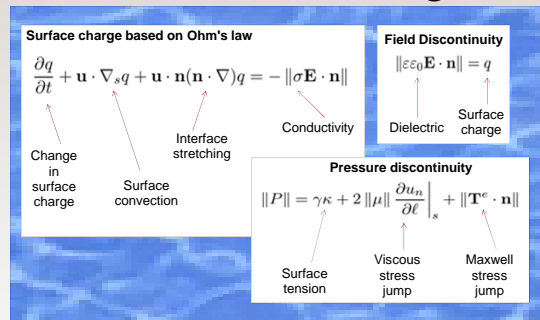
Project Goals

We intend to test physical mechanisms which have been proposed for this behavior (Bird, et. al. 2009), determine a parameter range of bouncing, total merging, and partial coalescence, and understand the size of daughter drops resulting from partial coalescence.

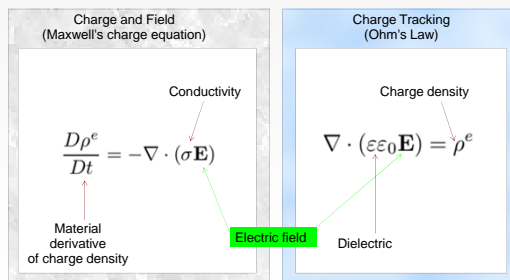
Dynamic Equations:



Surface Tracking:

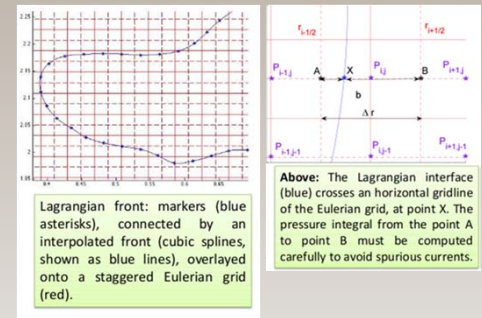


Charge Equations:



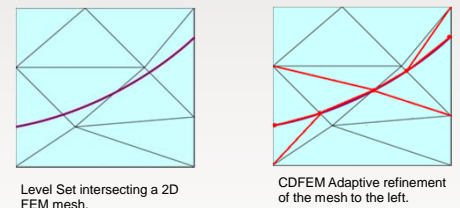
Method: Front Tracking

This method solves the Navier-Stokes on a staggered MAC (marker and cell) grid, and tracks the front using markers, advected with the fluid and connected with cubic splines.



Method: CDFEM

This method solves the Navier-Stokes using a Conformal Decomposition Finite Element (CDFEM) mesh. The interface is tracked using a level set (LS) method.



Summary: Work so far

We have formulated the governing equations and developed two numerical methods for multiphase flow. A theoretical solution has been obtained for a simple test case. We are currently developing a method to account for electric forces