Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

Self-Similar Taylor Cone Formation in Conducting Viscous Films: Computational Study of the Influence of Reynolds Number[1] THEODORE ALBERTSON, SANDRA TROIAN, California Institute of Technology, 1200 E. California Blvd., MC 128-95, Pasadena, CA — Previous studies by Zubarev (2001) and Suvorov and Zubarev (2004) have shown that above a critical field strength, an *ideal* (inviscid) conducting fluid film will deform into a singular profile characterized by a conic cusp. The governing equations for the electrohydrodynamic response beneath the cusp admit self-similar solutions leading to so-called blow-up behavior in the Maxwell pressure, capillary pressure and kinetic energy density. The runaway behavior in these variables reflects divergence in time characterized by an exponent of -2/3. Here we extend the physical system to include viscous effects and conduct a computational study of the cusp region as a function of increasing electrical Reynolds number Re_E. We employ a finite element, moving mesh algorithm to examine the behavior of the film shape, Maxwell pressure and capillary pressure upon approach to the blow-up event. Our study indicates that self-similarity establishes at relatively low Re_E despite the presence of vorticity, which is localized to the cusp surface region. With increasing Re_E, the period of self-similiarity extends further in time as the exponent changes from about -4/5 to the ideal value of -2/3, with slightly different values distinguishing the Maxwell and capillary stresses.

[1]T. Albertson gratefully acknowledges support from a NASA Space Technology Research Fellowship

Sandra Troian
California Institute of Technology

Date submitted: 01 Aug 2017 Electronic form version 1.4