Droplet Pinch-off in Liquid Sodium

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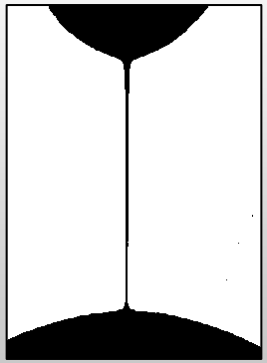
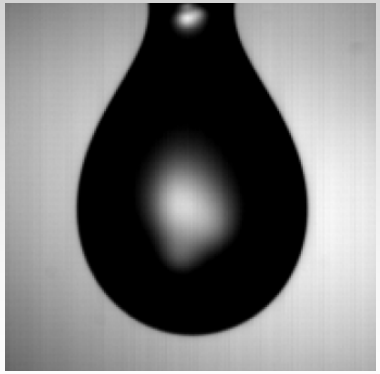


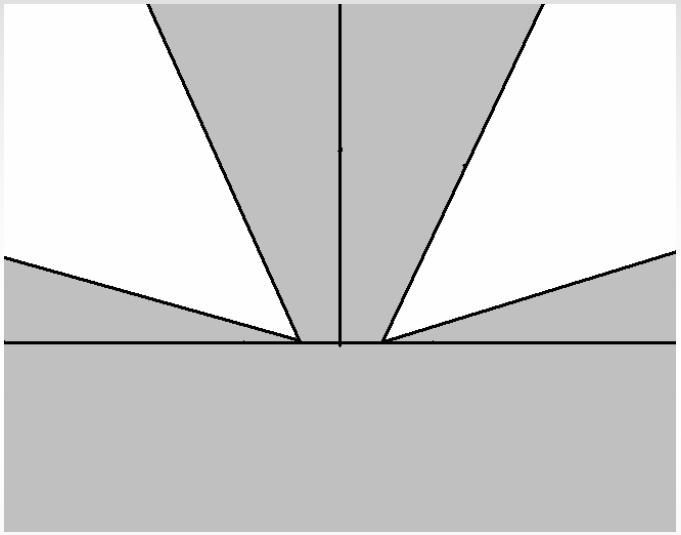
What is capillary pinch-off?



How is it important?

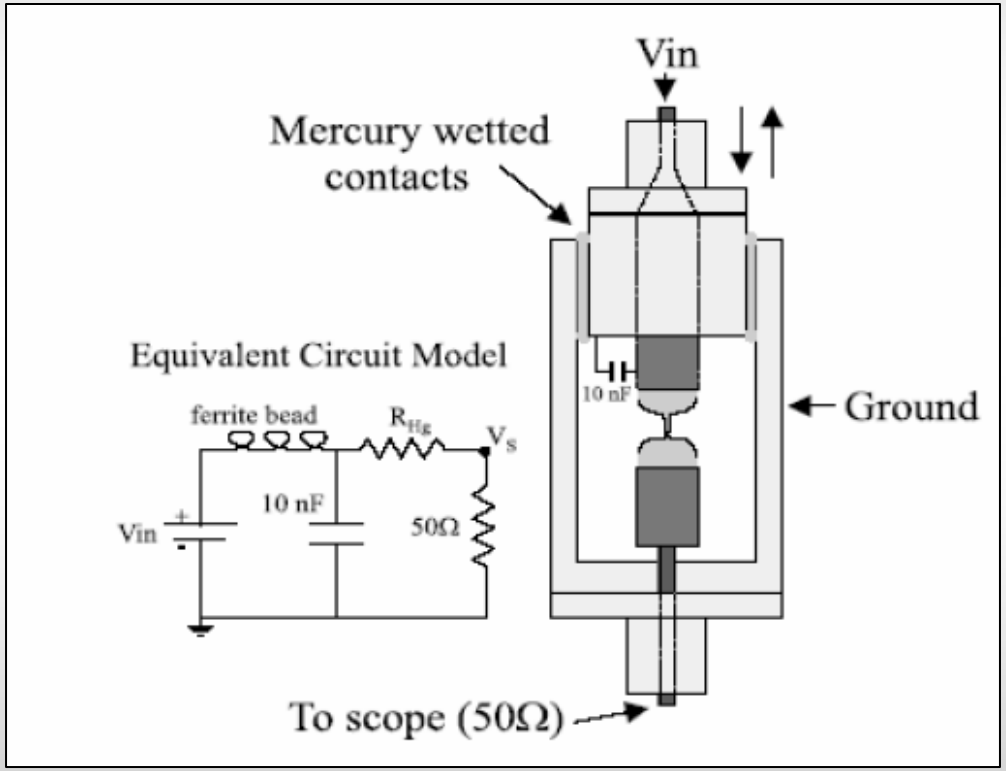
Optical Studies

- Strobe photography and high speed video
- Millimeter to 10 micrometer range
- Data restrictions: spatial resolution and reentrant profile of pinch-off



Electrical Studies

- Burton et al Phys. Rev. Lett. 92.244505 developed method for measuring minimum diameters of pinch-off by running an electric current through a drop of liquid mercury
- Micrometer to nanometer range
- Smallest diameter measured was about 2.7nm



Liquid Sodium vs. Mercury

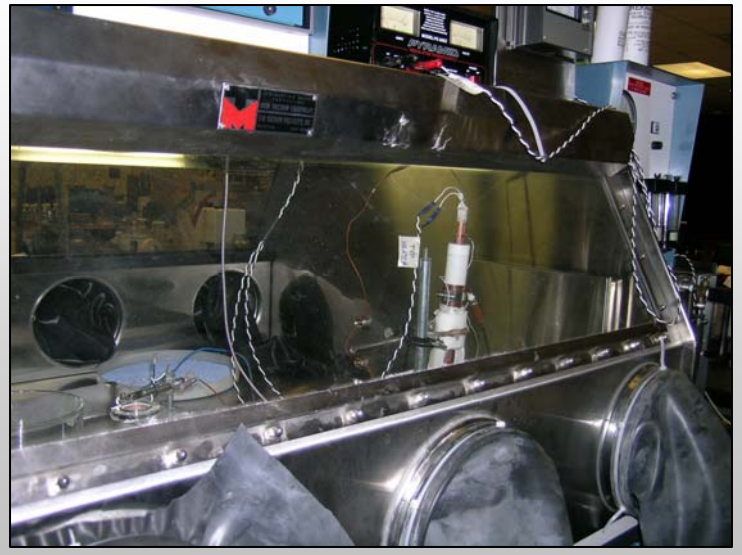
Less resistance= reduced RC constant.

Electrical resistivity Mercury: 961 nΩ·m (20 °C)

Electrical resistivity of Sodium: 47.7 nΩ·m (20 °C)

Safety Precautions:

- Gloved Box
- Desiccant
- Nitrogen

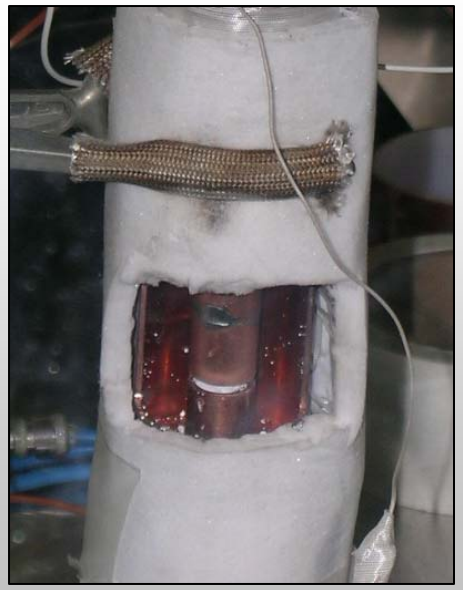


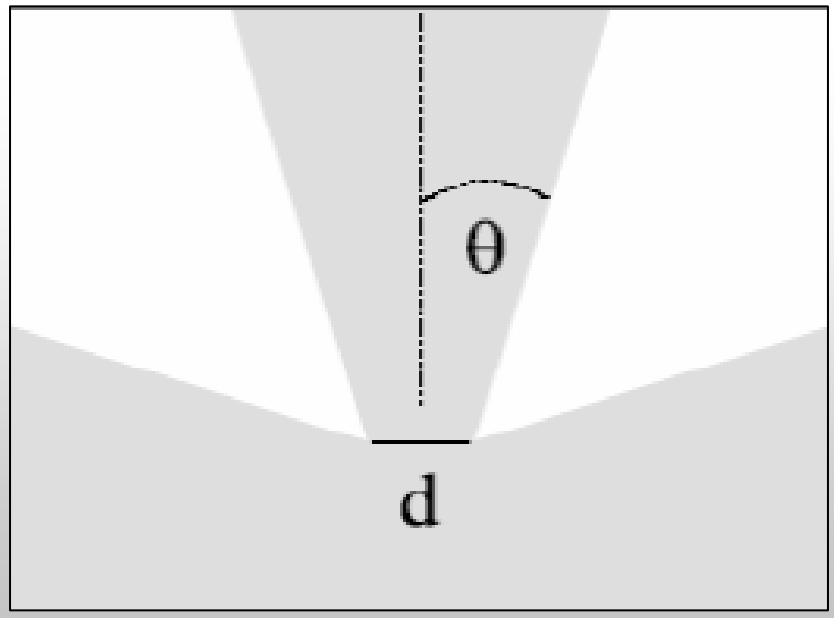
Finding minimum diameters:

•By measuring the resistance across the droplet, we can measure the minimum diameter d using the expression for resistance of a cone.

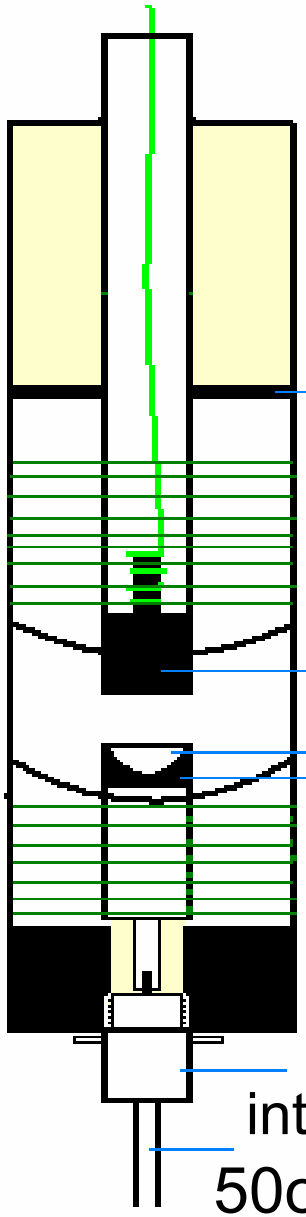
•Both theory and observation indicate that Θ ~18 °.

$$d = \frac{2\rho_r \cot(\theta)}{\pi R}$$





Design



Inner heater wire

Polytetrafluoroethylene (PTFE)

Outer heater wire

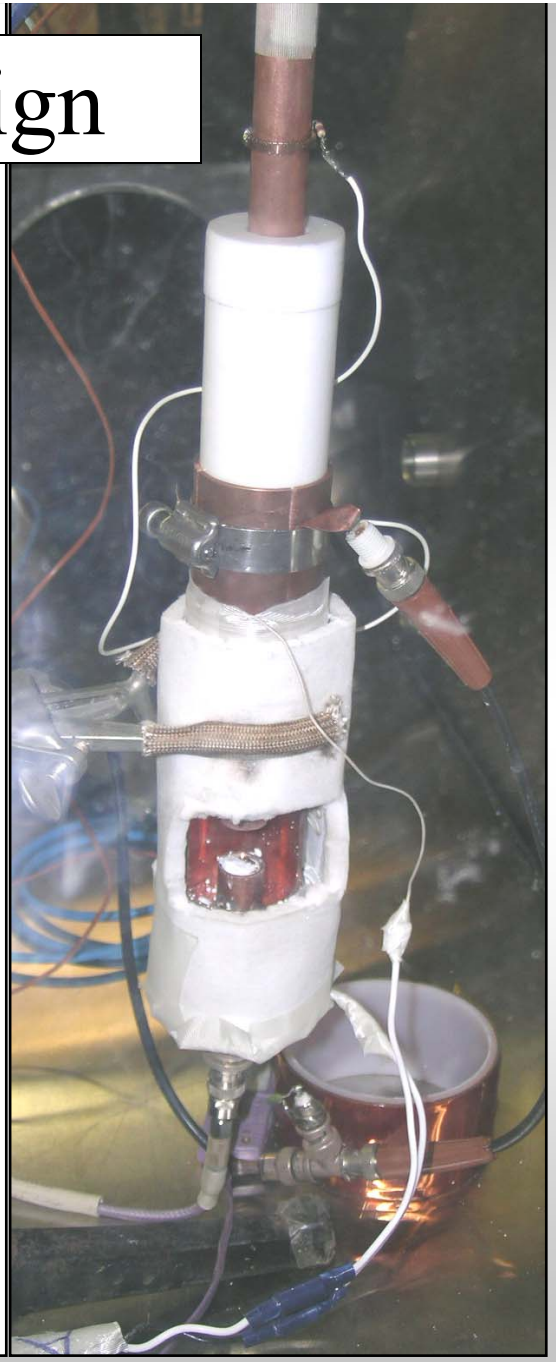
Surface mount circuit glued to bottom of PTFE for 50ohm termination

Moveable upper Cu electrode`

Liquid Sodium

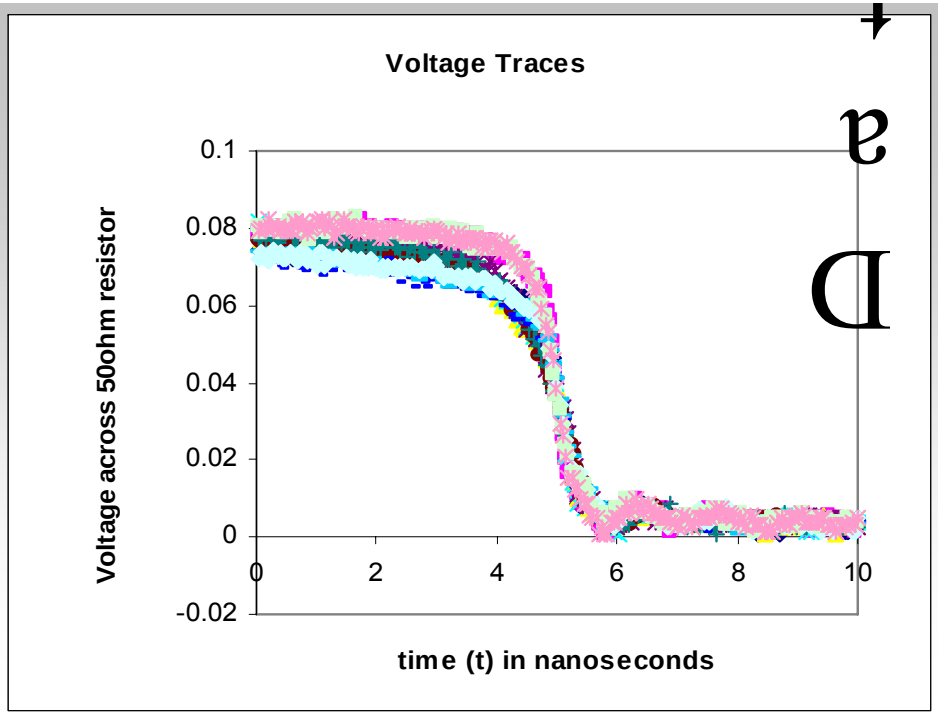
Bottom Cu electrode

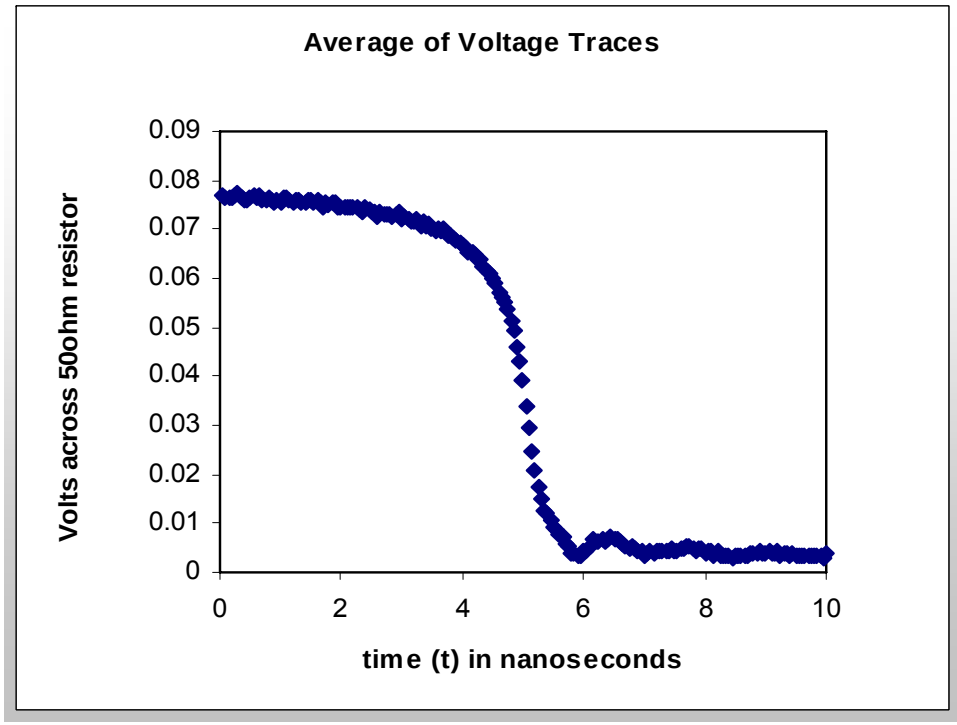
M connecter built directly into experiment with BNC attached 50ohm Coax Cable

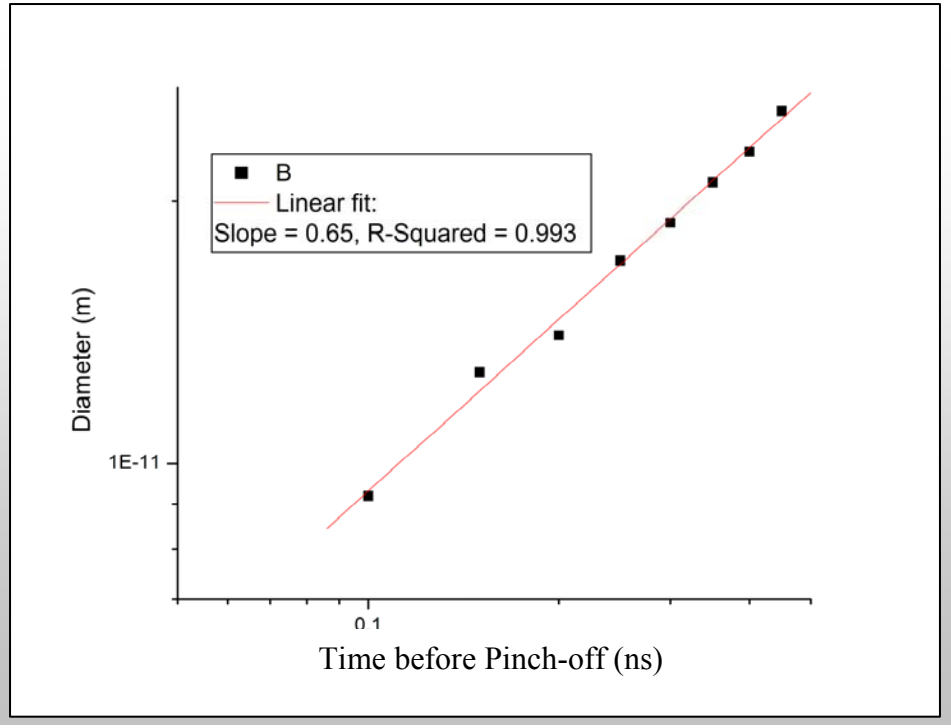


Data

- The following graphs show voltage traces and an average of the traces.
- The diameter measurements for all times before the pinch-off can be fit using a power-law model.
- Best fit for the exponent that governs the time dependence d is .65
- Predicted value for inviscid potential flow model = 2/3







Future Work:

More data analysis

Effect of magnets on this experiment

Thank You:

Daniel Lathrop

Don Martin

John Rodgers

Daniel Zimmerman