Modeling of the Nanometric Regime of Cone-Jets to Improve the Design and Understanding of Electrospray Thrusters

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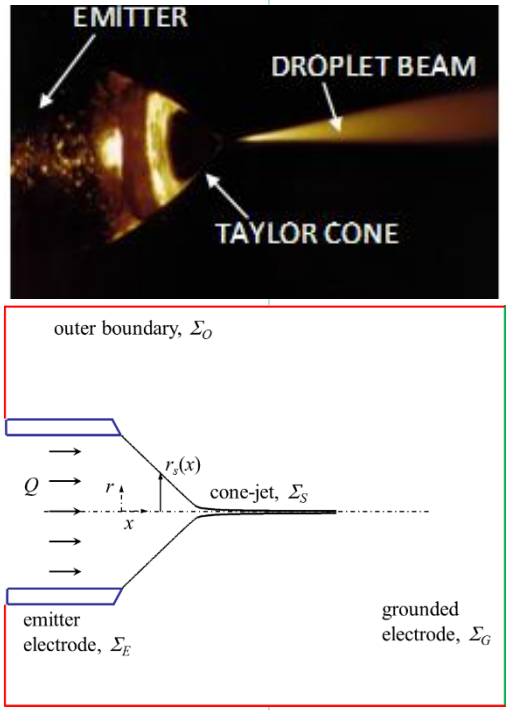
Research Objectives

- Development of a first-principles model of electrospraying, needed to optimize electrospray propulsion
- Key innovation: inclusion of novel physics, namely ion field evaporation and strong temperature gradients caused by energy dissipation. SOA models do not consider these phenomena, and electrospray thrusters are currently developed using experimental knowledge and invalid extrapolations
- No existing model takes into account relevant physics, therefore TRL entry is 1-2. Upon completion, a model relating thruster output and operational parameters will be available and demonstrated, i.e. exit TRL will be 3-4



Photograph of an electrospray in vacuum, and details of the model geometry

Approach

- The physics of cone-jets will be reproduced by constructing and numerically solving a model of cone-jets with realistic boundary conditions
- Model results will be validated with experimental measurements
- The model will be used to investigate problems of especial interest to electrospray propulsion such as: a) increasing the charge to mass ratio of droplets to increase *Isp*; b) the range of the pressure jump across the meniscus interface, which enables the development of a passive propellant feed system; and c) the effect of emitter temperature on the operation of the electrospray

Potential Impact

- A successful project will provide the model needed to design and optimize electrospray thrusters.
- Electrospray propulsion is an enabling technology for smallsats, one that will make it possible to use them in high value missions such as spacecraft constellations, formation flying, insertion in high altitude orbits, interplanetary voyage, etc. The fundamental knowledge provided by the model is needed to fulfill the potential of electrospray thrusters
- The model will also be useful for other electrospray applications based on the nanometric regime. The obvious applications is the use of nanodroplet beams for surface engineering (e.g. high rate sputtering, surface amorphization and texturing, etc.), which also requires the acceleration of nanodroplets to hypervelocities