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Emission and Charging of Nanoaerosol Plumes from a Taylor Cone-Jet YUNSHAN WANG, Dept. of Chemical and Biomolecular Engr., Univ. of Notre Dame, MING K. TAN, Dept. of Chemical and Biomolecular Engr. and Dept. of Aerospace and Mechanical Engr., Univ. of Notre Dame, DAVID B. GO, Dept. of Aerospace and Mechanical Engr., Univ. of Notre Dame, HSUEH-CHIA CHANG, Dept. of Chemical and Biomolecular Engr., Univ. of Notre Dame — We examine the explosive atomization at the tip of a Direct-Current Taylor cone-jet for an electrolyte, which is the most common mode for electrospray proteomic mass spectrometry applications but whose fundamental mechanism remains unknown. With scaling arguments and imaging experiments, we demonstrate the underlying physics to be the induction of a polarized region with a high space charge density in the microjet by the dominant Taylor harmonic of the cone. The induced space charge density increases along the jet until Coulombic repulsion among the space charges, when their separation is below the Bjerrum length, triggers the explosive microjet atomization and emits charged nanoaerosols in distinct conic plumes. As the induced microjet space charge can be estimated by a nonlinear Guoy-Chapman equilibrium analysis for strong electrolytes, the jet breakup length, current-flow rate correlation, aerosol size/charge and plume angle are strong functions of ionic strength and interfacial tension and are quantitatively captured by our universal scaling laws.

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