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On the physics of hydrodynamic and electrohydrodynamic tip-streaming revealed from published experimental literature

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Thousands of published experimental measurements on electrospray and flow focusing are analyzed in this work. The scaling analysis shows two cases of uniformly valid incomplete similarity for the emitted jet diameter for electrospray and flow focusing within the parametrical space of steady capillary jetting from experiments. These cases, reducible to a single formulation, compellingly points to a single underlying and remarkably simple physics for both phenomena. In electrospray, however, the scaling analysis of the emitted current does not show the degree of uniformity exhibited by the jet diameter, reflecting the dominance of different charge transport mechanisms based on different hydrodynamic regimes. The existence of analytical conical tip solutions is also discussed, and the events of "unconditional jetting" delimited; under these findings, the smallest attainable droplet sizes from experiments are analyzed. These minimum sizes exhibit two interesting additional cases of incomplete similarity for electrospray and flow focusing, uniformly valid in the corresponding spaces of hydrodynamic and electrohydrodynamic Weber and Capillary numbers.