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Electrohydrodynamic Liquid Disintegration in Micro-, Meso- and Nanoscopic Dimensions[1]

AKOS VERTES, George Washington University

The electrohydrodynamic dispersion of liquids spans length scales from 1 mm to 1 nm and involves temporal variations from 1 s to 10 ps. The disintegration mechanisms are diverse and, due to the differences in the dominating forces, vary on the micro-, meso- and nanoscale extending to lower boundaries of 1 μm, 10 nm and 1 nm, respectively. Using fast imaging, spray current measurements, phase Doppler anemometry and molecular dynamics calculations, we followed the behavior of electrified liquids in the three most common geometries, spherical, pendant drop and slender jet, with dimensions ranging from 100 μm to 1 nm. Microscale disintegration involves jet ejection from conical surface deformations, jet breakup due to varicose, kink and ramified jet instabilities, and asymmetric droplet fission resulting in side jets. As the liquid dimensions shift from the microscopic dimensions where the processes are governed by the surface tension and the Maxwell stress, to the meso- and nanoscale, thermal fluctuations become increasingly important. The presence of charges in nanodroplets leads to enhanced surface fluctuations, the formation of extreme protrusions and eventually solvated ion evaporation. Charging of slender nanojets results in longer shape relaxation times along with the fission of systems charged below the Rayleigh limit. In collaboration with Jelena Lusic and Peter Nemes, George Washington University.

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