LadHyX Seminar – June 11th, 10:45

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Universal $\sqrt{\log}$ scaling of slender-body end effects: from Maxwell's wire to phoretic Janus rods

We revisit the self-propulsion of slender phoretic Janus rods, showing that the scaling of their speed with aspect ratio lies halfway between that established for spheroidal particles and that predicted by earlier theories for cylinders.

On the way to this result, we resolve a long-standing electrostatics problem dating back to Maxwell: how is the scaling of charge density modified near the ends of a thin conducting cylinder? Resolving this puzzle provides the mathematical machinery needed to make sense of the phoretic problem.

The scaling argument entails a local resummation of the series solution to the integral equation of slender-body theory; we thus address a notorious difficulty in that theory associated with the end regions of cylinders — and more general "truncated" shapes tapered on the diameter scale. Given its mathematical origins, the scaling possesses "universality" across broad classes of geometries and physical scenarios (including diffusion, Stokes flow, elasticity, acoustics and plasmonics).

Joint work with Gunnar G. Peng (University College London)