**Existence of the Navier slip condition for liquid flows around nanoparticles**

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*Synopsis*

The Navier slip boundary condition is regularly used in nanoscale liquid flows to characterise the interaction at the liquid-solid interface. In this talk we present a standardised experimental protocol to measure the slip length on individual nanoparticles with exquisite precision. A constant slip length—independent of particle size—of 2.7 $\pm $ 0.6 nm is found, providing evidence of the Navier slip conditions existence in liquid flows.

*Introduction*

The use of the Navier slip condition (see Fig. 1) in gas flows is justified rigorously from Boltzmann’s kinetic theory of gases. No such parallel framework exists for liquid flows where molecular dynamics simulations provide the strongest evidence for the existence of the Navier slip condition. As dictated by kinetic theory, the Navier slip length is a constitutive property (independent of particle size), that holds when the flow is *unconfined* (flow away from the surface must be in a continuum state)*.*

**Fig. 1.** Streamlines of liquid flowing past a sphere at zero Reynolds number. The slip length, $b$, is the extrapolated distance into the solid surface where the no-slip boundary condition would hold.

*Methods*

In this talk, we present a standardised experimental protocol using a new modality of suspended microchannel resonators (SMRs) to measure the slip length on individual nanoparticles, satisfying the conditions above. SMRs are cantilevered inertial mass sensors with a fluid channel embedded in the interior of the device that allow ultra-sensitive measurements of suspended particles in liquid environments1,2; see Fig. 2. When a negatively buoyant nanoparticle is introduced into this channel, the particle drives a flow in the liquid which is intimately connected to the boundary condition at the liquid-solid interface3—this is quantified with a new theoretical framework.

**Fig. 2.** Optical micrograph of a Suspended Microchannel Resonator and inlet/outlet channels. The SMR contains a fluid channel embedded in its interior.

*Results*

Experiments consisting of repeat measurements on individual gold nanoparticles are collected by flowing a single particle back and forth through the SMR. Hundreds of measurements are performed on each nanoparticle to overcome the frequency noise inherent in these experiments. A constant slip length of 2.7 $\pm $ 0.6 nm is found which, crucially, is independent of particle size, thus providing experimental validation of the Navier slip condition for liquids.

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