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Massive radius-dependent flow slippage in carbon nanotubes[1]

ALESSANDRO SIRIA, ELEONORA SECCHI, CNRS - ENS, SOPHIE MARBACH, ENS, ANTOINE NIGUS, CNRS - ENS, DEREK STEIN, Brown University, LYDRIC BOCQUET, CNRS - ENS — Nanofluidics is the frontier where the continuum picture of fluid mechanics confronts the atomic nature of matter. Recent reports indicate that carbon nanotubes exhibit exceptional water transport properties due to nearly frictionless interfaces and this has stimulated interest in nanotube-based membranes for desalination, nano-filtration, and energy harvesting. However, the fundamental mechanisms of water transport inside nanotubes and at water-carbon interfaces remain controversial, as existing theories fail to provide a satisfying explanation for the limited experimental results. We report a study of water jets emerging from single nanotubes made of carbon and boron-nitride materials. Our experiments reveal extensive and radius-dependent surface slippage in carbon nanotubes (CNT). In stark contrast, boron-nitride nanotubes (BNNT), which are crystallographically similar to CNTs but electronically different, exhibit no slippage. This shows that slippage originates in subtle atomic-scale details of the solid-liquid interface.

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