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Superpermeability of water through graphene based membranes
RAHUL RAVEENDRAN NAIR, RAKESH JOSHI, School of Physics and Astronomy, University of Manchester, HENGAN WU, CAS Key Laboratory of Mechanical Behavior and Design of Materials, University of Science and Technology of China, JAYARAM NARAYANAN, IRINA V. GRIGORIEVA, ANDRE K. GEIM, School of Physics and Astronomy, University of Manchester — Permeation through nanometre-pore materials has been attracting unwavering interest due to fundamental differences in governing mechanisms at macroscopic and molecular scales, the importance of water permeation in living systems, and relevance for filtration and separation techniques. One of the most spectacular findings in this field was the observation that carbon nanotubes and other hydrophobic nanocapillaries allow anomalously fast permeation of gases and liquids and, in particular, of water. In this contribution we show that membranes made from graphene oxide which are impermeable to liquids, vapours and gases, including helium, but allow unimpeded permeation of water (H_2O permeates through the membranes at least 10^{10} times faster than He). We attribute these seemingly incompatible observations to a nearly frictionless flow of a monolayer of water through two dimensional capillaries formed by closely spaced graphene sheets. The flow is driven by a large capillary-like pressure and normally limited only by evaporation from the wetted surface of the membranes. The permeation can be stopped by either reducing graphene oxide or inducing a reversible drying transition in low humidity, which narrow nanocapillaries in both cases. I will also give an overview of our latest results on ion permeation through these membranes.

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