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Slip at the Liquid/Solid Interface: A Dynamical Theory[1]
ALEXANDER ROXIN, CNRS, YALING LIU, WING-KAM LIU, SETH LICHTER, Northwestern University — Despite numerous experiments and computational studies of slip at the liquid/solid interface, a theory of how, why and when slip occurs has remained elusive. Statistical mechanical theories treat only the limit of small shear rates and determine only average quantities and cannot predict how slip occurs. We develop a theory of the dynamics of liquid molecules adjacent to a solid. Results from the theory agree with molecular-dynamics simulations. The theory shows that slip occurs through several different mechanisms. Individual liquid molecules can hop along the solid surface or the entire layer can slide as a single flexible sheet. Which mechanism occurs depends on the shear rate and the liquid and solid parameters. The theory shows how these parameters can be adjusted in order to enhance or curtail slip. In particular, we show how the surface properties can be tuned to yield slip, even for strongly wetting surfaces.

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