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Nanofluidic Brownian Ratchet via atomically-stepped surfaces
AMIR RAHMANI, CARLOS COLOSQUI, State Univ of NY- Stony Brook — Theoretical analysis and fully atomistic molecular dynamics simulations reveal a Brownian ratchet mechanism by which thermal motion can drive the directional displacement of liquids confined in micro- or nanoscale channels and pores. The particular systems discussed in this talk consist of two immiscible liquids confined in a slit-like nanochannel with atomically-stepped surfaces. Mean displacement rates reported in molecular dynamics simulations are in close agreement with theoretical predictions via analytical solution of a Smoluchowski equation for the probability density of the position of the liquid-liquid interface. The direction of the thermally-driven displacement of liquid is determined by the nanostructure surface geometry and thus imbibition or drainage can occur against the direction of action of capillary forces. The studied surface nanostructure with directional asymmetry can control the dynamics of wetting processes such as capillary filling, wicking, and imbibition in porous materials. The proposed physical mechanisms and derived analytical expressions can be applied to design nanofluidic and microfluidic devices for passive handling and separation.

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