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Slip versus Friction : Modifying the Navier condition EVANGELOS KOTSALIS, ETHZ, JENS WALTHER, ETHZ & TU Denmark, PETROS KOUMOUTSAKOS, ETHZ — The modeling of fluid-solid interfaces remains one of the key challenges in fluid mechanics. The prevailing model, attributed to Navier, defines the fluid "slip" velocity as proportional to the wall shear and a parameter defined as the slip length. Several works have in turn proposed models for this slip length but no universal model for the slip velocity has been accepted. We present results from large scale molecular dynamics simulations of canonical flow problems, indicating, that the inadequacy of this classic model, stems from not properly accounting for the pressure field. We propose and validate a new model, based on the fundamental observation that the finite "slip" velocity is a result of an imbalance between fluid and solid intermolecular forces. An excess force on the fluid elements will lead to their acceleration which in turn may result in a slip velocity at the interface. We formulate the slip velocity in terms of fluid-solid friction F_f and propose a generalized boundary condition: $F_f = F_s + F_p = \lambda_u u_s + \lambda_p p$ where p denotes the pressure, and $\lambda_u$and λ_p the viscous and static friction coefficients, for which universal constants are presented. We demonstrate that the present model can overcome difficulties encountered by the classical slip model in canonical flow configurations.

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