Abstract Submitted
for the MAR10 Meeting of
The American Physical Society

Mesoscopic Hydrodynamic Theory of Electric-Field Driven Water Pumping Through Nanochannels[1] ANGBO FANG, Department of Physics, Hong Kong University of Science and Technology — We develop a mesoscopic hydrodynamic theory for water flow through nanochannels. The physical meaning of vortex flux, which is responsible for translation-rotation (T-R) dynamic coupling, is analyzed and shown to be relevant only at mesoscopic length and time scales. Then we apply a variational approach to derive the hydrodynamic equations of motion along with consistent hydrodynamic boundary conditions, taking into account the important T-R coupling in surface layers. Analytic solutions for the velocity profile are obtained and analyzed for general fluid-solid interfacial dynamic properties. Under a homogenous rotating electric field, the water pumping efficiency is dominated by the mismatch degree of dynamic properties (such as slip length and surface layer thickness) of the two opposite interfaces confining the nanochannel. The averaged flow velocity is in general shown to be independent of the channel width.

[1]This work is supported by Award No. KAUST08/09.SC01, made by King Abdullah University of Science and Technology (KAUST).

Angbo Fang
Department of Physics, Hong Kong University of Science and Technology

Date submitted: 06 Jan 2010 Electronic form version 1.4