Abstract Submitted
for the MAR14 Meeting of
The American Physical Society

Nano-funnels as electro-osmotic "tweezers and pistons"[1] YANQIAN WANG, University of North Carolina at Chapel Hill, SERGEY PANYUKOV, P. N. Lebedev Physics Institute, Russian Academy of Sciences, JINSHENG ZHOU, LAURENT D. MENARD, J. MICHAEL RAMSEY, MICHAEL RUBINSTIEN, University of North Carolina at Chapel Hill — An electric field is used to force a DNA molecule into a nano-channel by compensating the free energy penalty that results from the reduced conformational entropy of the confined macromolecule. Narrow nano-channels require high critical electric fields to achieve DNA translocation, leading to short dwell times of DNA in these channels. We demonstrate that nano-funnels integrated with nano-channels reduce the free energy barrier and lower the critical electric field required for DNA translocation. A focused electric field within the funnel increases the electric force on the DNA, compresses the molecule, and increases the osmotic pressure at the nano-channel entrance. This "electro-osmotic piston" forces the molecule into the nano-channel at lower electric fields than those observed without the funnel. Appropirately designed nano-funnels can also function as tweezers that allow manipulation of the position of the DNA molecule. The predictions of our theory describing double-stranded DNA behavior in nano-funnel – nano-channel devices are consistent with experimental results.

[1]Thanks for the financial support from NSF (DMR-1309892, DMR-1121107, DMR-1122483), NIH (1-P50-HL107168, 1-P01-HL108808-01A1, R01HG02647), NHGRI and CF Foundation.

Yanqian Wang
University of North Carolina at Chapel Hill

Date submitted: 15 Nov 2013 Electronic form version 1.4