

DNA Capture in nanoscale pores - How does it happen?

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Abstract:

Nanopores are an emerging class of biosensors optimized for probing the structure of biopolymers at the single-molecule level. A unique, powerful feature of the nanopore method is its ability to linearly “slide and read” extremely long unlabeled biopolymers, particularly attractive for analyzing native (i.e., unamplified) DNA molecules. It is anticipated that nanopores will play a prominent role as the future-generation tool for DNA sequencing, where only a small number of genome copies will be required for complete genomic coverage, and where long read-lengths (>1 kbp) are crucial. While we as well as others has studied extensively the electrophoretic driven transport of DNA through nanopores, much less is known about its capture mechanism, which is prerequisite for any nanopore analysis. Here I will report on new, and surprising results showing that the capture rate increases with DNA length for medium length biopolymers, but becomes length-independent for longer DNA. We introduce a simple non-equilibrium model (and numerical analyses) to explain these results, emphasizing the crucial role of electrostatics outside the pore. Moreover, we implement a simple way to manipulate the capture rate by introducing salt gradients across the pore, thus increasing the method's sensitivity by orders of magnitude, allowing us to detect unprecedentedly small DNA sample.