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Nanopores and nanofluidics for single DNA studies

Lab-on-a-chip fluidic technology takes inspiration from electronic integrated circuits, from which its name, its fabrication methods, and its “smaller, cheaper, faster” paradigm are derived. For silicon-based electronics, miniaturization eventually gave rise to qualitatively different behavior, as quantum mechanical phenomena grew increasingly important. As we shrink fluidic devices down to the nanoscale to probe samples as minute as a single molecule, what physical phenomena will dominate in this new regime, and how might we take advantage of them? This talk will focus on our studies of single DNA molecules using nanofluidic devices and solid-state nanopores.

We are studying how nanofluidic structures, whose critical dimensions are tens to hundreds of nanometers, can manipulate long DNA molecules by a variety of nanoscale phenomena, including electrokinetics, hydrodynamics, Coulomb interactions, and the statistical properties of polymers. Our work also focuses on solid-state nanopores, single-nanometer-scale devices that can not only manipulate single molecules, but also detect them electronically. The basic principle behind this is that when DNA is electrophoretically driven through a nanopore, it blocks a measureable fraction of the ionic current that is transmitted through the pore. Thanks to its size, the nanopore also forces each base along the DNA to pass through in sequence, suggesting intriguing possibilities for genetic analysis.

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