UIC COLLOQUIUM
Department of Physics

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"Precision Measurements and Control of Single Molecules in Free Solution"

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By looking at molecules as individuals, single-molecule experiments can provide rich details that complement and deepen our understanding from bulk measurements. The ultimate goal of most single-molecule techniques is to reveal population-level or time-dependent heterogeneity in a system of interest by directly monitoring individual particles in a near-native environment. However, confining a single molecule within an observation volume for long enough to detect a small, noisy signal – without substantially perturbing that signal – is challenging, especially in situations where tethering particles in place may restrict throughput or directly change the sample's behavior. Since nearly all molecules possess some native charge, electrophoretic forces that are generated by application of electric fields are an attractive option for manipulating particles without physical attachment. Similarly, the electric field-induced motion of ions in the double layer near the walls of a micro- or nanofluidic channel can induce electroosmotic flow, which imparts hydrodynamic forces that can be used to manipulate particles.

Here, I will present an overview of my recent work related to two unique single-molecule techniques that employ electric fields to enable control and precision measurements of single molecules and nanoscale particles in free solution. These strategies enable concurrent multi-parametric readout of the states of those objects, which then can be used to classify their nature and behaviors. First, I will discuss the use of static electric fields to draw charged biopolymers to and through small solid-state nanopores, which can be used to resistively sense variations in chemical or geometric structure along the length of the analyte molecule. Second, I will present results obtained via an Anti-Brownian Electrokinetic (ABEL) trap, a technique in which Brownian motion is directly counteracted by active electrophoretic or electroosmotic feedback to maintain the position of a single molecule within a small confocal region. Because single molecules can be trapped for many seconds each, high-precision fluorescence measurements can report on either static or dynamic heterogeneity in their structure and interactions.

Because these techniques utilize electrophoretic and electroosmotic forces, the native charge of the analyte or surrounding medium are sufficient to achieve tether-free nanoscale confinement of single molecules and nanoparticles, providing highly versatile sensing platforms to address both applied and basic biochemical, biophysical, and biomedical challenges

The Department of Physics Colloquium will be held at 3pm in 2214 SES.