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Detection and interrogation of biomolecules via nanoscale probes: From fundamental physics to DNA sequencing

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A rapid and low-cost method to sequence DNA would revolutionize personalized medicine [1], where genetic information is used to diagnose, treat, and prevent diseases. There is a longstanding interest in nanopores as a platform for rapid interrogation of single DNA molecules. I will discuss a sequencing protocol based on the measurement of transverse electronic currents during the translocation of single-stranded DNA through nanopores. Using molecular dynamics simulations coupled to quantum mechanical calculations of the tunneling current, I will show that the DNA nucleotides are predicted to have distinguishable electronic signatures in experimentally realizable systems. Several recent experiments support our theoretical predictions. In addition to their possible impact in medicine and biology, the above methods offer ideal test beds to study open scientific issues in the relatively unexplored area at the interface between solids, liquids, and biomolecules at the nanometer length scale [1].

[1] M. Zwolak and M. Di Ventra, "Physical Approaches to DNA Sequencing and Detection," Rev. Mod. Phys. 80, 141 (2008).

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