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Modeling DNA sequencing at the Nanoscale

Fast and low-cost DNA sequencing methods would revolutionize medicine: a person could have his/her full genome sequenced so that drugs could be tailored to his/her specific illnesses; doctors could know in advance patients' likelihood to develop a given ailment; cures to major diseases could be found faster. However, this goal of "personalized medicine" is hampered today by the high cost and slow speed of DNA sequencing methods: it costs several million dollars and several months time to sequence one human genome. I will first give an overview of recent proposals to achieve fast DNA sequencing using several techniques, ranging from optical to capacitive. I will then discuss the protocol we suggest which would require the measurement of transverse currents during the translocation of single-stranded DNA into nanopores and support our conclusions with a combination of molecular dynamics simulations coupled to quantum mechanical calculations of electrical current in experimentally realizable systems. [1,2,3,4]

[1] M. Zwolak and M. Di Ventra, "Physical approaches to DNA sequencing and detection", Rev. Mod. Phys. **80**, 141 (2008).
[2] M. Zwolak and M. Di Ventra, "Electronic signature of DNA nucleotides via transverse transport", Nano Lett. **5**, 421 (2005).
[3] J. Lagerqvist, M. Zwolak, and M. Di Ventra, "Fast DNA sequencing via transverse electronic transport", Nano Lett. **6**, 779 (2006).
[4] J. Lagerqvist, M. Zwolak, and M. Di Ventra, "Influence of the environment and probes on rapid DNA sequencing via transverse electronic transport", Biophys. J. **93**, 2384 (2007).