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Probing DNA in nanopores via tunneling: from sequencing to "quantum" analogies

MASSIMILIANO DI VENTRA, University of California, San Diego

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 [1]. However, this goal of "personalized medicine" is hampered today by the high cost and slow speed of DNA sequencing methods. In this talk, I will discuss the sequencing protocol we suggest which requires the measurement of the distributions of transverse currents during the translocation of single-stranded DNA into nanopores [2-5]. I will support our conclusions with a combination of molecular dynamics simulations coupled to quantum mechanical calculations of electrical current in experimentally realizable systems [2-5]. I will also discuss recent experiments that support these theoretical predictions. In addition, I will show how this relatively unexplored area of research at the interface between solids, liquids, and biomolecules at the nanometer length scale is a fertile ground to study quantum phenomena that have a classical counterpart, such as ionic quasi-particles, ionic "quantized" conductance [6,7] and Coulomb blockade [8]. Work supported in part by NIH.

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