Extended Abstract: Plateaus and Jumps in Single-Molecule DNA Unzipping Experiments

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We first discuss denaturation of double-stranded DNA as a function of force and temperature [1]. Under physiological conditions, sequence heterogeneity dominates single molecule force-extension curves starting about 7 pN below a 15 pN unzipping transition. The dynamics of the unzipping fork exhibits anomalous pauses and jumps in a similar range above the transition. Although reminiscent of the stops and starts associated with DNA replication and repair, the jerky motion in this case arises entirely from sequence heterogeneity in a defect-free duplex. We compare energy landscapes for unzipping the DNA of viruses which infect *E. coli*, and find that energy barriers typically scale as the square root of the genome size. Recent observations of jumps and plateaus in the unzipping of lambda phage DNA at constant force in the laboratory of Mara Prentiss [2, 3] are consistent with these ideas.

Similar energy landscapes might be expected together with anomalous drift and diffusion in other biological situations, including molecular motors near the stall force. Indeed, translocation of RNA or DNA through a pore can be biased due to the different chemical environments on the two sides of a membrane, while molecular motor motion is biased through a coupling to chemical energy. An externally applied force can oppose these biases. We argue that anomalous dynamics also occurs in these systems near the stall force, characterized by an average displacement which grows sublinearly as t^μ with $\mu < 1$ [4]. In this regime, the observed “velocity” of a DNA unzipping fork, a molecular motor or a translocating polymer will depend on the time scale of the experiment.

References

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