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There and (slowly) back again: Entropy-driven hysteresis in a model of DNA overstretching STEPHEN WHITELAM, SANDER PRONK, PHILLIP GEISSLER, University of California at Berkeley — DNA in vivo experiences protein-mediated tensile forces large enough to alter the structure and stability of the hybridized state. Experiments show that double-stranded DNA, when pulled along its axis, elongates abruptly at a force of about 65 pN. Two physical pictures have been developed to describe this overstretched state of DNA. The first introduces a new hybridized phase, called S-DNA, structurally and thermodynamically distinct from standard B-DNA. The second picture proposes that strong forces simply induce a phase transition to a molten state consisting of unhybridized single strands. Little thermodynamic evidence exists to discriminate between these competing pictures. Here we show that within a microscopic model of DNA, the kinetics associated with these two pictures are very different. The nonextensive entropy of unhybridized regions in our model produces hysteresis in a cycle of overstretching and relaxing whenever melting is substantial. Since hysteresis is observed in experiments only at high temperatures, our study requires the proposed S form of DNA in order to account for overstretching kinetics at low temperature.

Stephen Whitelam
University of California at Berkeley

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