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Torque-induced buckling behavior in stretched intertwined DNAs[1] SUMITABHA BRAHMACHARI, JOHN F. MARKO, Northwestern Univ
— Two intertwined DNA molecules (a DNA 'braid') is a common occurrence in the cell and is a relevant substrate for the study of topoisomerase and recombination enzymes. Single molecule experiments have observed the signature of a buckling transition in braids under tensile and torsional stress. We present a free energy model for braided DNA to investigate the mechanical properties of these structures. Our model is based on the semi-flexible polymer model for double helix DNA and is in quantitative accord with the experiments. We identify coexistence of a force-extended state with a plectonemically buckled state, which is reminiscent of single supercoiled DNA behavior. However, the absence of an intrinsic twist modulus in braided DNA results in unique mechanical properties such as non-linear torque in the extended state. At the buckling transition, we predict a jump in the braid extension due to the plectoneme end loop which acts as a nucleation barrier. We investigate the effect of salt concentration on the mechanical response of braids, e.g. we find that buckling starts at a lower linking number for lower salt concentration, the opposite of what is seen for single supercoiled DNAs. Also, concentrations less than 20 mM monovalent salt favor formation of multiple plectoneme domains.

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