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Intrinsic and force-generated cooperativity in a theory of DNA bending proteins HOUYIN ZHANG, JOHN F. MARKO, Department of Physics and Astronomy, Northwestern University, Evanston Illinois 60208, USA — We study a statistical-mechanical model of the binding of DNA-bending proteins to the double helix including applied tension and binding cooperativity effects. We find that intrinsic cooperativity of binding sharpens force-extension curves, and causes enhancement of fluctuation of extension and protein occupation. This model also allows us to estimate the intrinsic cooperativity in experiments by measuring the peak value of the slope of extension vs. chemical potential curves. In addition, we find clear signatures of cooperativity in the mechanical signals even in the absence of explicit intrinsic (energetic) cooperativity. To further understand this effect, we analyze a model with a pair of bends at variable spacing and derive a spacing-dependent free energy of interaction between the two proteins. We find that the interaction, in a model without helical phasing, is always attractive, and has an exponential decay as a function of bend spacing. We also find that for forces greater than k_BT/A, where A is the persistence length, the interaction correlation length varies as $\sqrt{k_BTA/(4f)}$, and the interaction strength varies approximately linearly with force until the proteins are forced to unbend. Our results apply to single molecule experiments on DNA-bending proteins and also suggest mechanisms for control of the distribution of proteins bound along DNA in vivo.

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