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Stretching wormlike chains of finite length

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The problem of stretching flexible polymers was covered in a seminal paper by John F. Marko and Eric D. Sigga in 1995, where they used the wormlike chain model to calculate the force required to stretch long segments of DNA. Their approach used a ground state dominance method to solve the modified diffusion equation, applicable to long (flexible) chains only. Here, using the same Green's function approach, we go beyond their work and present the force extension relations for a full range of chain lengths, from rodlike molecules through to semiflexible and flexible polymers. In addition, we calculate the variance in extension, as well as the mean squared perpendicular displacement for all lengths. For each of the properties, we provide analytic results for the rodlike limit. Numerical methods were used to directly solve the modified diffusion equation for semiflexible polymers, with the ground state dominance theory again applied to the long chain limit. By covering all three regimes, this work completes the understanding of the stretching of ideal polymers from the wormlike-chain perspective.

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