Reply to "Comment on 'Theory of high-force DNA stretching and overstretching'"

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In his Comment to an earlier paper [Phys. Rev. E **67**, 051906 (2003)] Lam points out an error in Eq. (20) of the original paper. Here we show that use of the corrected expression produces results very similar to those presented in our original paper, so our qualitative conclusions are unchanged.

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As Lam points out in the preceding Comment [1], there is an error in Eq. (20) of our paper [2]. Instead of

$$y(\omega) = \frac{2\sqrt{2}\pi^{3/2}\omega e^{-2\tilde{\ell}-\frac{(2\omega+\tilde{f})^2}{8\tilde{\ell}}}\operatorname{csch}(2\omega)}{\sqrt{-\tilde{\ell}}(2\omega+\tilde{f})} \times\left[\operatorname{erf}\left(\frac{i}{2\sqrt{2\tilde{\ell}}}(\tilde{f}+4\tilde{\ell}+2\omega)\right) - \operatorname{erf}\left(\frac{i}{2\sqrt{2\tilde{\ell}}}(\tilde{f}-4\tilde{\ell}+2\omega)\right)\right], \quad (1)$$

it should, in fact, read

$$y(\omega) = \frac{2\sqrt{2}\pi^{3/2}\omega e^{-2\tilde{\ell}-\frac{(2\omega+\tilde{f})^2}{8\tilde{\ell}}}\operatorname{csch}(2\omega)}{\sqrt{-\tilde{\ell}}(2\omega+\tilde{f})} \times\left[\operatorname{erf}\left(\frac{i}{2\sqrt{2\tilde{\ell}}}[4\tilde{\ell}+(\tilde{f}+2\omega)]\right) - \operatorname{erf}\left(\frac{i}{2\sqrt{2\tilde{\ell}}}[4\tilde{\ell}-(\tilde{f}+2\omega)]\right) - 2\operatorname{erf}\left(\frac{i}{2\sqrt{2\tilde{\ell}}}(\tilde{f}+2\omega)\right)\right]. \quad (2)$$

We have repeated the calculation of the force-extension curves exactly as it is described in Ref. [2] but using Eq. (2), and we have refitted the resulting curves to the experimental data from Ref. [3]. The results of this revised fit are collected in Fig. 1.

Although the best-fit parameters have changed somewhat, our conclusions still stand that (a) the extensible discrete persistent chain (EDPC) model describes the high-force stretching of ssDNA slightly better than either the extensible wormlike chain (EWLC) or the extensible freely jointed chain (EFJC); and (b) the enthalpic stretch constant is significantly larger (stiffer) than the value obtained with those simpler models. We would like to stress, however, that the error in the original Eq. (20) does not affect any of our results concerning the overstretching transition in dsDNA, as in that case we passed to a continuum limit before fitting the theory to experiments and in doing so effectively bypassed the error.

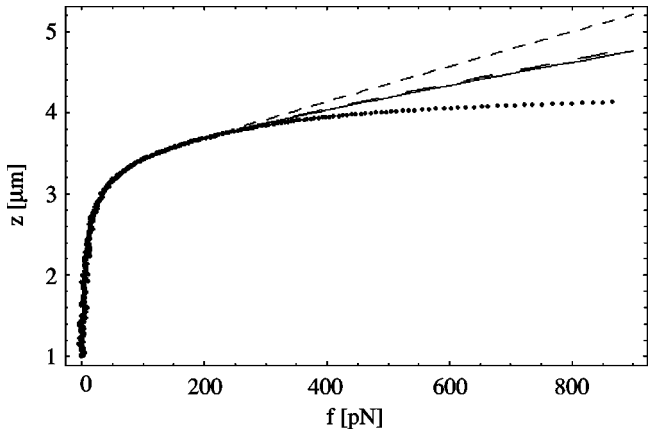

FIG. 1. Fit of the extensible DPC model (solid line) to the single-strand DNA stretching data (dots) supplied by Rief; see Ref. [3]. The fit shown was obtained for $b=0.21$ nm, $E=2.8\times10^3$ pN, $L_{\mathrm{tot}}=3.7$ μm, and $\kappa^{\mathrm{DPC}}=3/2(k_BT/0.71\ \mathrm{nm})$. In addition, the dashed and long-dashed lines show the corresponding best fits to the extensible WLC and FJC, respectively. All fits include the data points only for forces between 20 pN and 250 pN. Values for χ^2 were EFJC, $\chi^2=0.20$; EWLC, $\chi^2=0.13$; and EDPC, $\chi^2=0.12$ at $N=1271$. We ignore the lowest-force points because of complications induced by hairpins and other secondary structures in the DNA.

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We conclude by expressing our gratitude to Dr. Lam for bringing to light this unfortunate error.

[1] P. M. Lam (unpublished).
[2] C. Storm and P. C. Nelson, Phys. Rev. E **67**, 051906 (2003).
[3] M. Rief, H. Clausen-Schaumann, and H. E. Gaub, Nat. Struct. Biol. **6**, 346 (1999).