3.032 Mechanical Behavior of Materials

Fall 2007

Gaussian distribution function for Freely Jointed Chain of known n and b:

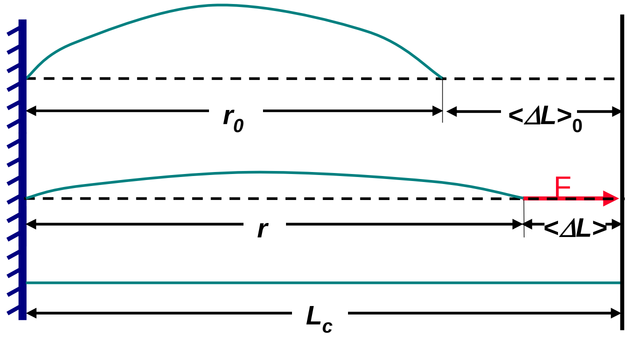
$$P(r,n,b)dr = 4\pi r^2 \left(\frac{2\pi n b^2}{3}\right)^{-3/2} \cdot \exp\left(\frac{-3r^2}{2nb^2}\right)$$

Worm Like Chain (WLC) model: Often expressed as $FL_p/k_BT = \ldots$

$$F = \frac{k_B T}{L_p}\left[\frac{1}{4\left(1-\frac{r}{L_c}\right)^2} + \frac{r}{L_c} - \frac{1}{4}\right]$$

3.032 Mechanical Behavior of Materials

Fall 2007



Single filament extension (WLC)

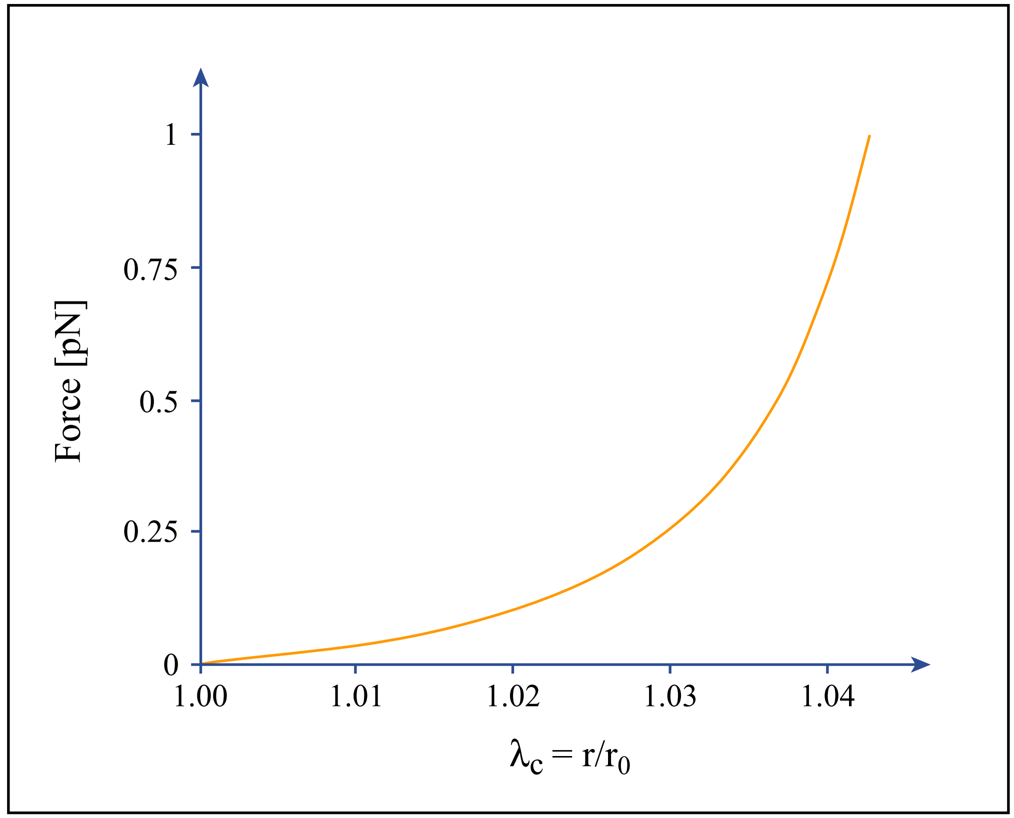


Figure by MIT OpenCourseWare.

Force-extension (F vs. λ) of F-actin filaments, polymerized actin protein bundles that comprise the cytoskeleton in tissue cells, exhibit hyperelastic or rubber elasticity predicted by the Worm-Like Chain (WLC) model.

† Van Vliet and Lee, NanoToday (2006).

3.032 Mechanical Behavior of Materials

Fall 2007

Please see: Fig. 1 in Bustamante, C., et al. "Entropic Elasticity of Lambda-phage DNA." *Science* 265 (September 1994): 1599-1600.
and

Fig. 1a and b in Smith, Steven B., et al. "Direct Mechanical Measurements of the Elasticity of Single DNA Molecules by Using Magnetic Beads." *Science* 258 (November 1992): 1122-1126.

Lecture 17 (10.19.07)

3.032 Mechanical Behavior of Materials

Fall 2007

Please see: Fig. 2 in Bouchiat, C., et al. "Estimating the Persistence Length of a Worm-Like Chain Molecule from Force-Extension Measurements." *Biophysical Journal* 76 (January 1999): 409-413.

λ-DNA (used in 3.034 Lab 3):

- How long is it (#AA)?
- How stiff is it (dF/dz)?
- How many AA in the rigid segments (L_p)?
- How much force does it take to uncoil coiled DNA?

Biophysical Journal Volume 76 January 1999 409–413 4

Estimating the Persistence Length of a Worm-Like Chain Molecule from Force-Extension Measurements

C. Bouchiat,[*] M. D. Wang,[#] J.-F. Allemand,[§] T. Strick,[§] S. M. Block,[¶] and V. Croquette[§]
[*]LPT, ENS, Laboratoire propre du CNRS, Paris, France; [#]Department of Physics-LASSP, Cornell University, Ithaca, New York 14853

Lecture 17 (10.19.07)