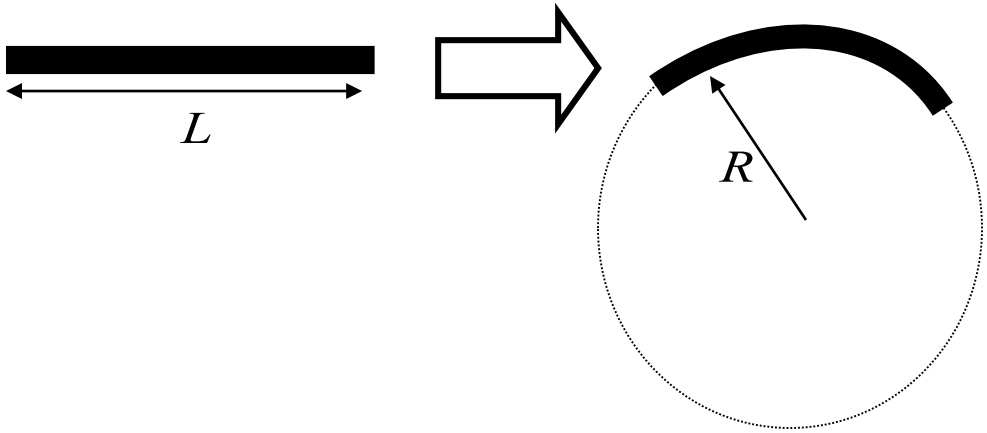
Life at Low D

Lecture II: Virtual Lab

Bend Energy

$$U_{Bend} = \frac{EI}{2}\frac{L}{R^2}$$

Energy required to bend filament of Length L into circular arc of Radius, R



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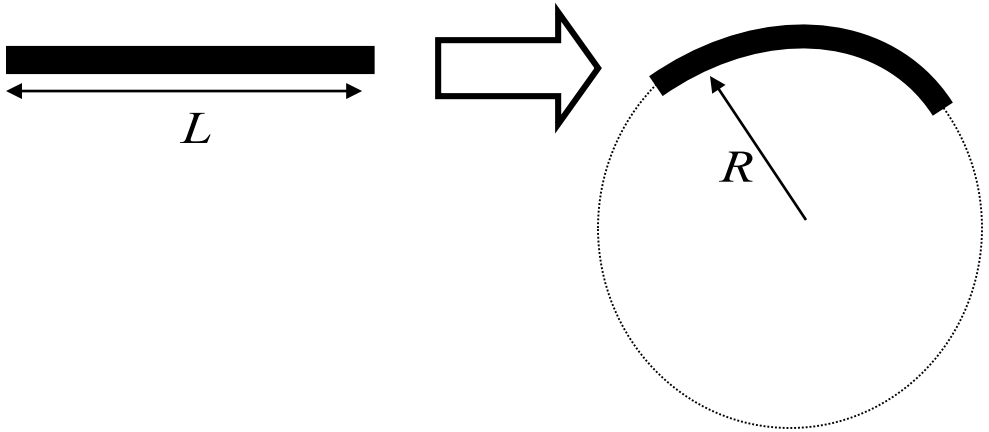
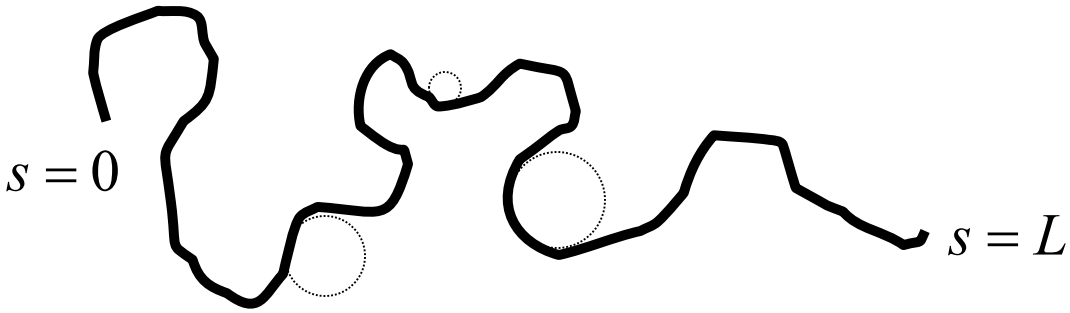
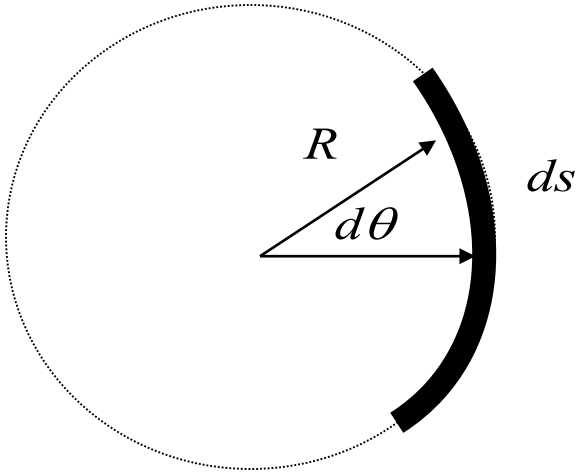
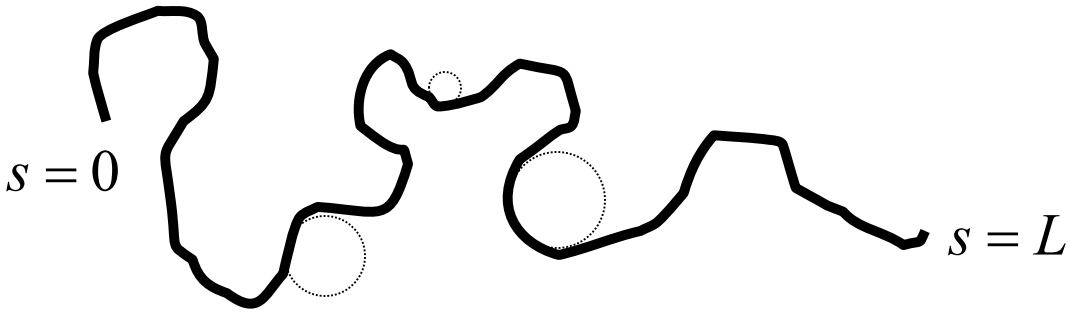




$$U_{Bend} = \sum_{all\ arcs} U^{o}_{Bend} = \frac{EIL}{2}\int_{0}^{L}\frac{1}{R^2(s)}ds$$

Bend Energy





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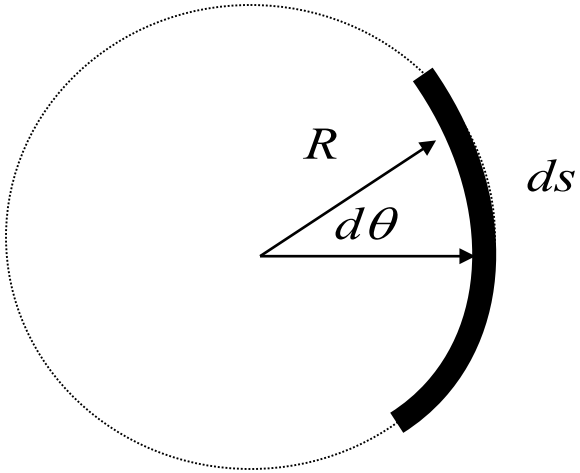
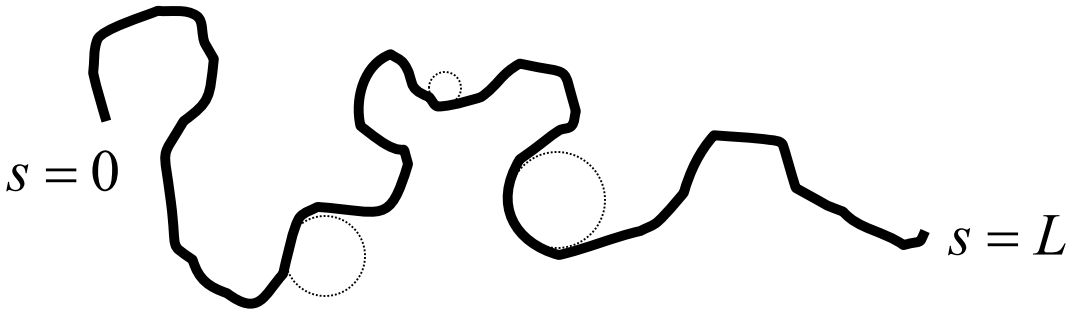
Bend Energy



$$ds = Rd\theta$$



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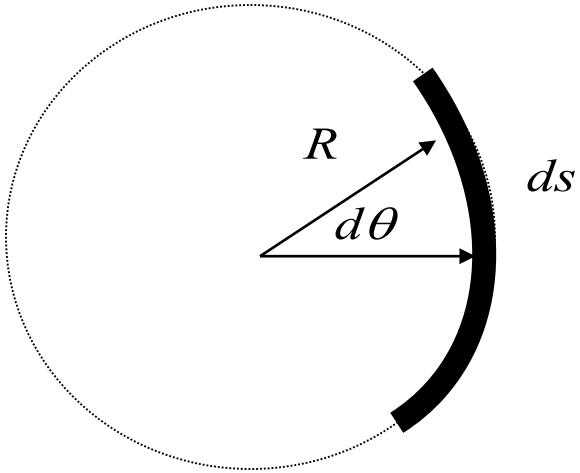
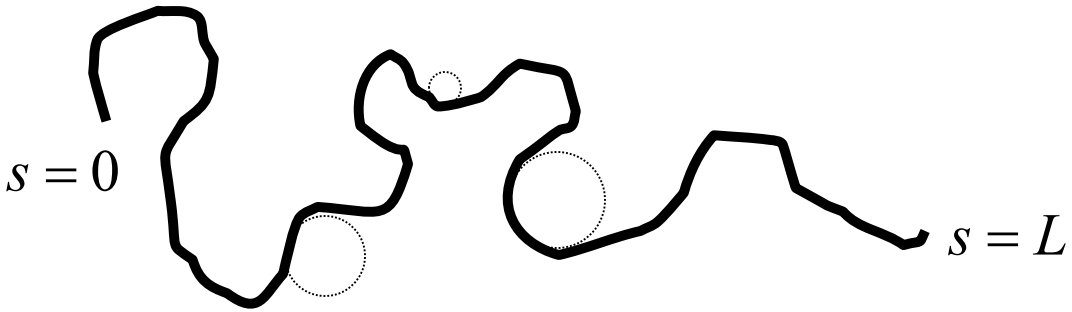
Bend Energy



$$ds = Rd\theta \quad \Rightarrow \quad \frac{1}{R} = \frac{d\theta}{ds}$$



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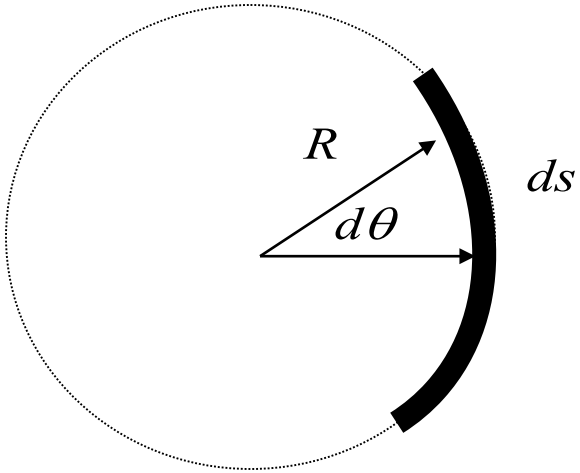
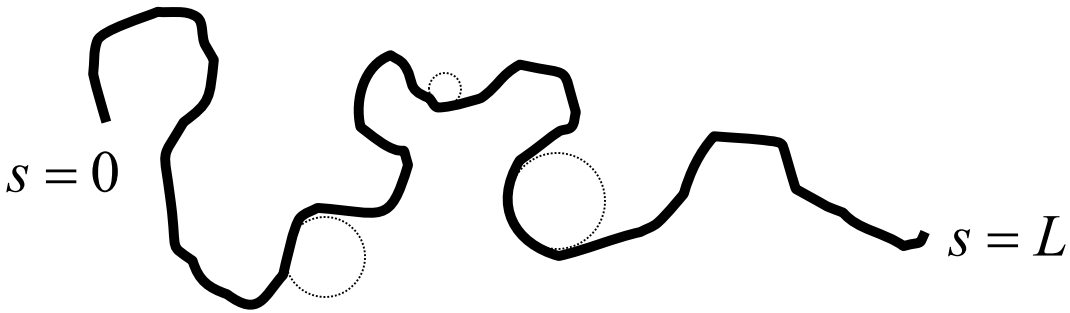
Bend Energy



$$ds = Rd\theta \Rightarrow \frac{1}{R} = \frac{d\theta}{ds} \Rightarrow \frac{1}{R^2} = \left(\frac{d\theta}{ds}\right)^2$$

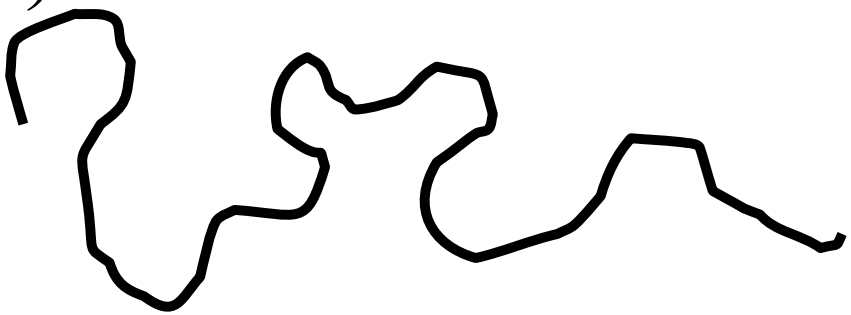


$$U_{Bend} = \sum_{all\ arcs} U^{o}_{Bend} = \frac{EIL}{2}\int_0^L \frac{1}{R^2(s)}ds$$

Bend Energy

$$U_{Bend} = \frac{EIL}{2}\int_0^L \left(\frac{d\theta}{ds}\right)^2 ds$$

(1)



$$U_{Bend}(1) >> U_{Bend}(2)$$

(2)

Bend Energy

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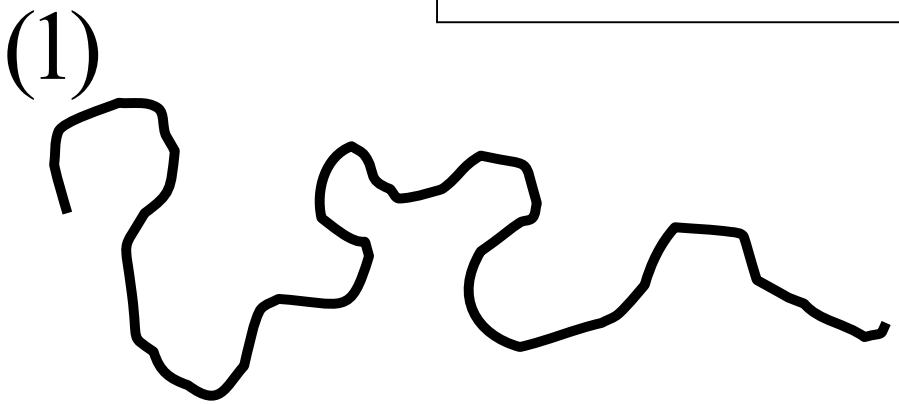
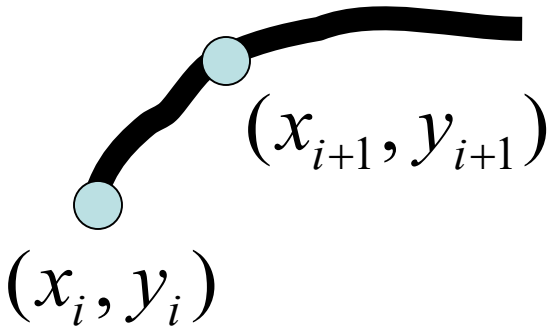
(1)





Bend Energy

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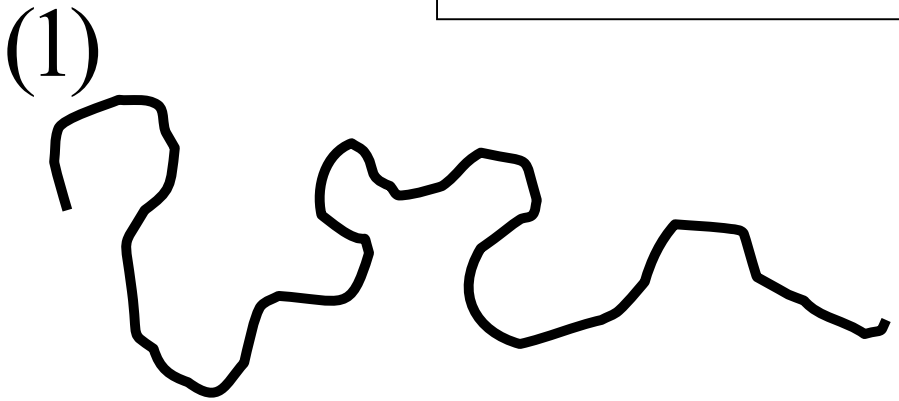

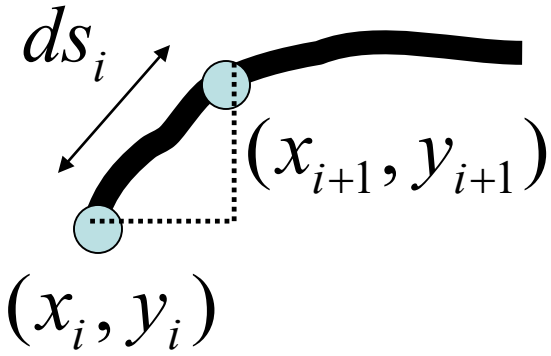

$$ds_i = \sqrt{(x_{i+1} - x_i)^2 + (y_{i+1} - y_i)^2}$$

Bend Energy

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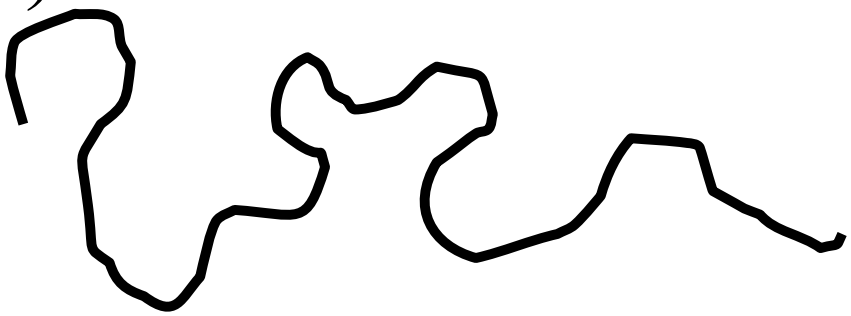

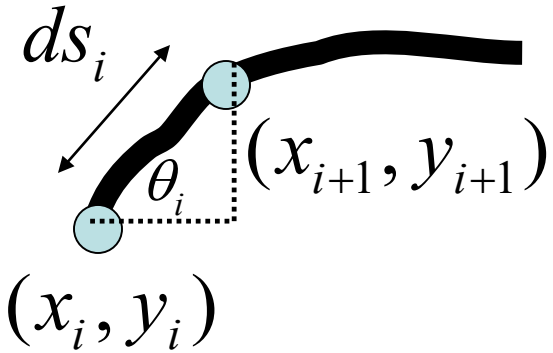

$$ds_i = \sqrt{(x_{i+1} - x_i)^2 + (y_{i+1} - y_i)^2}$$

$$\tan[\theta_i] = \frac{y_{i+1} - y_i}{x_{i+1} - x_i}$$

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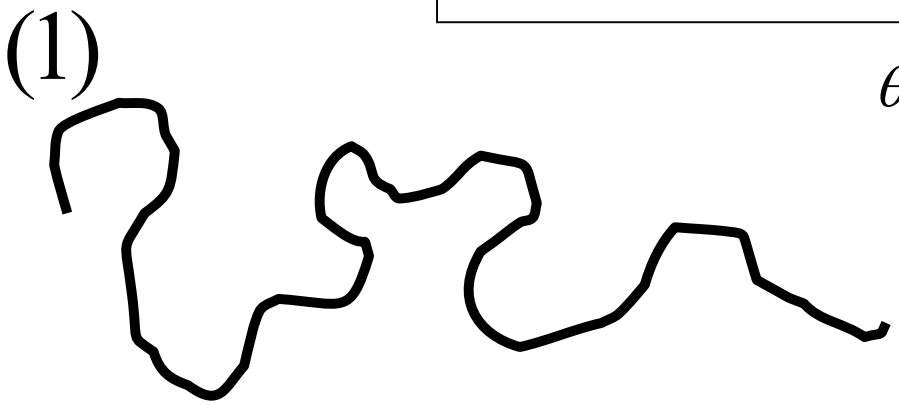

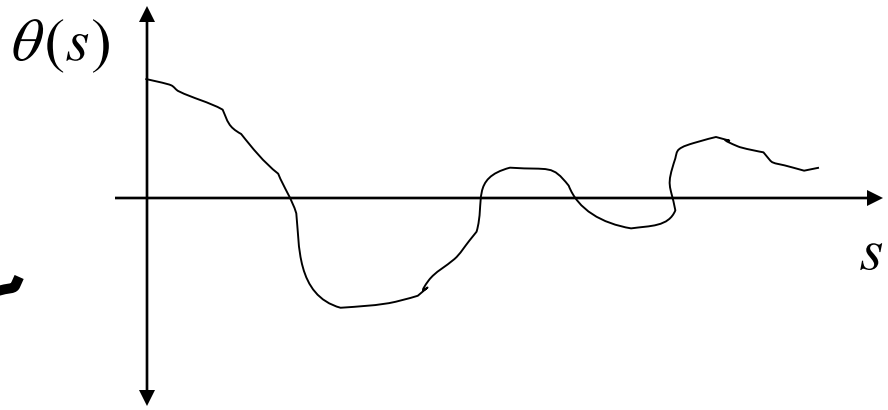

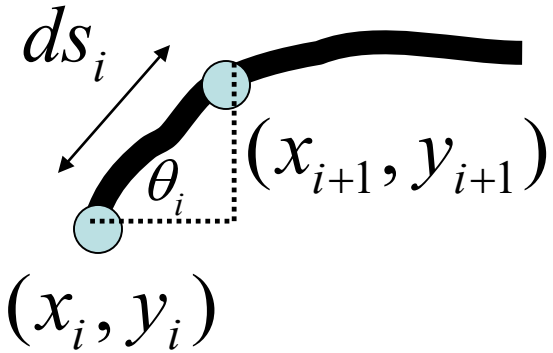

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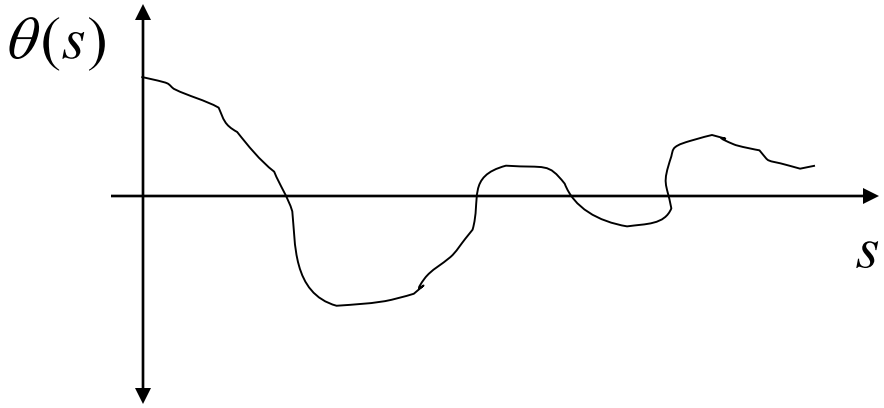
$$\theta(s) = \sqrt{\frac{2}{L}}\sum_n \theta(q)\cos\left(\frac{n\pi}{L}s\right)$$



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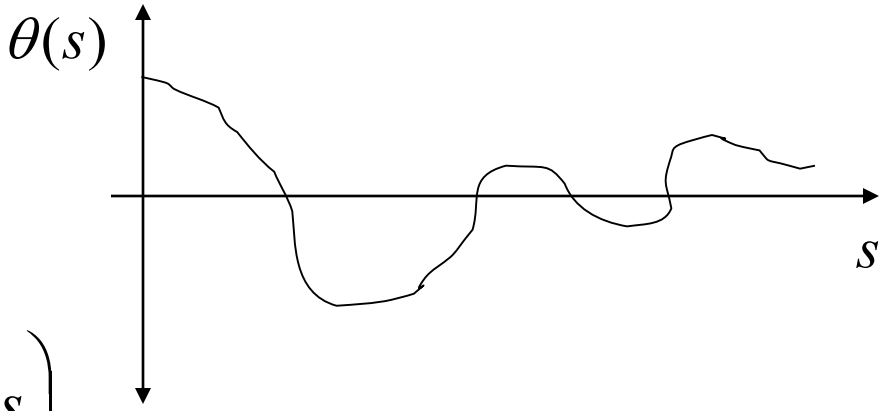

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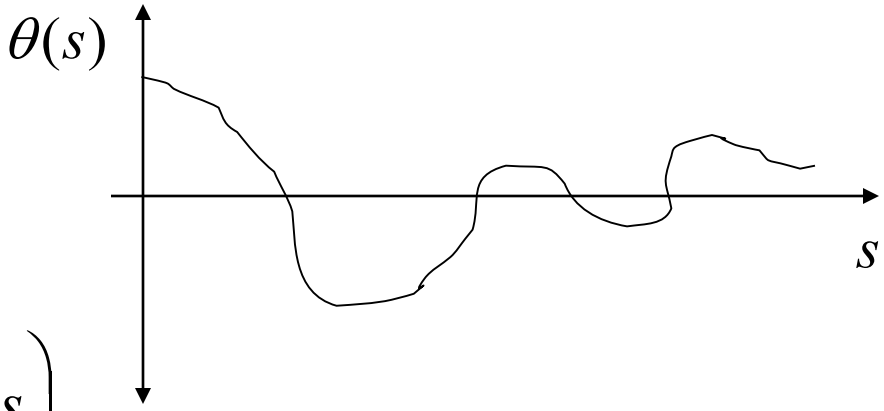

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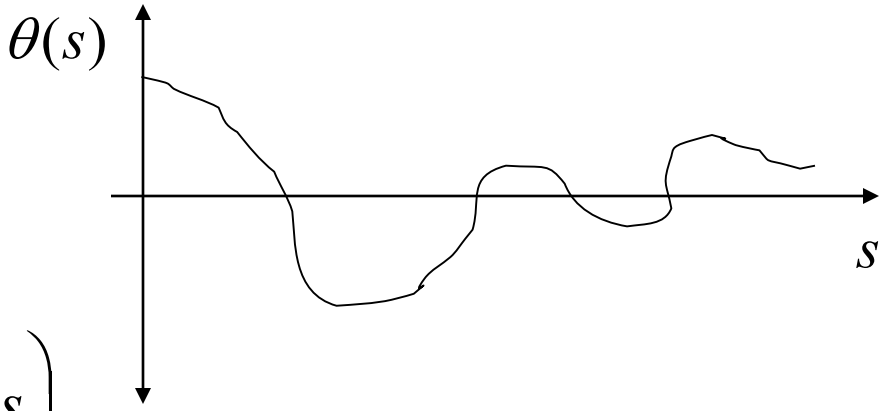

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$$\int_0^L \left(\frac{d\theta}{ds}\right)^2 ds = \frac{2}{L}\sum_{n,m}\theta(q)\theta(k)\left(\frac{n\pi}{L}\right)\left(\frac{m\pi}{L}\right)\int_0^L \sin\left(\frac{m\pi}{L}s\right)\sin\left(\frac{n\pi}{L}s\right)ds$$

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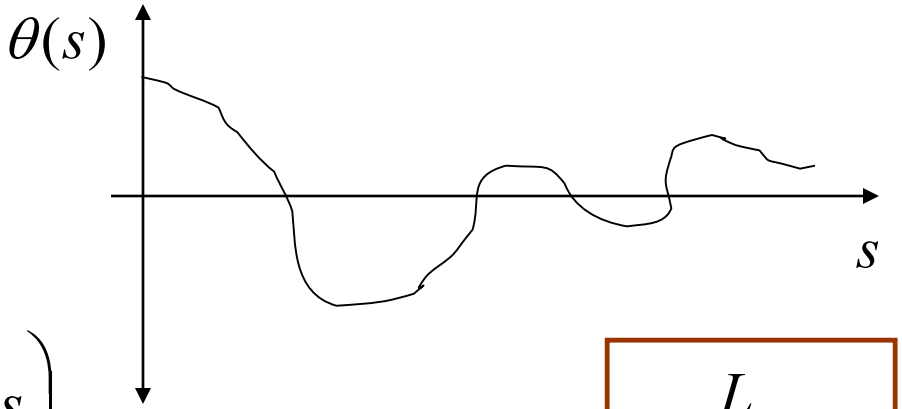

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$$= \frac{L}{2}\delta_{mn}$$

Bend Energy

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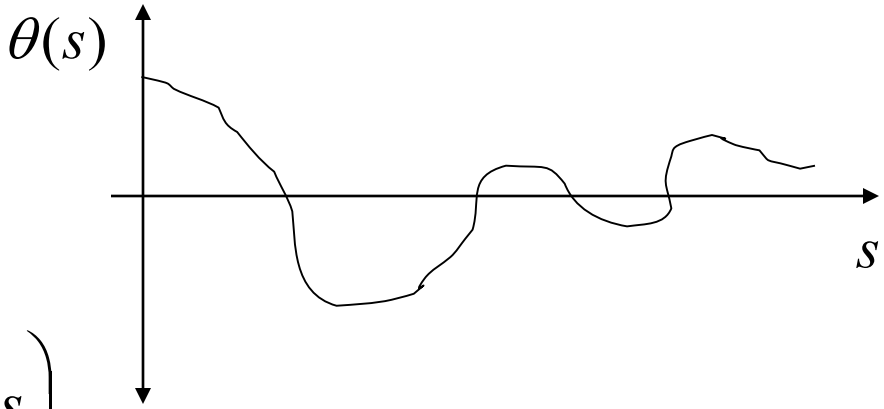

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$$\int_0^L \left(\frac{d\theta}{ds}\right)^2 ds = \sum_n q^2\theta^2(q)$$

Bend Energy

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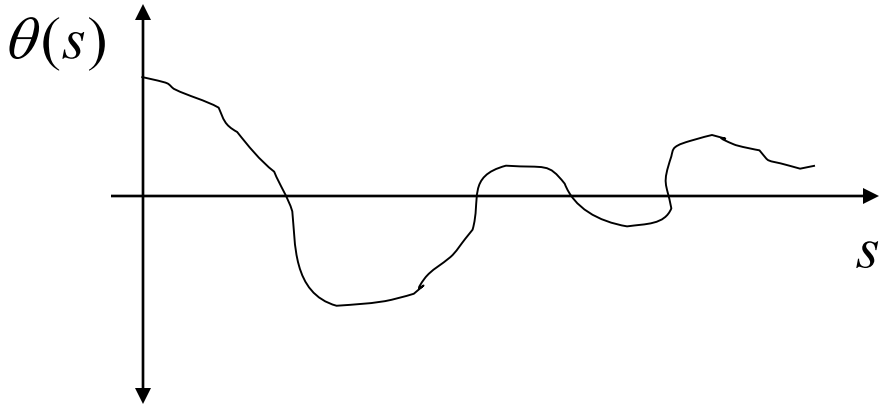

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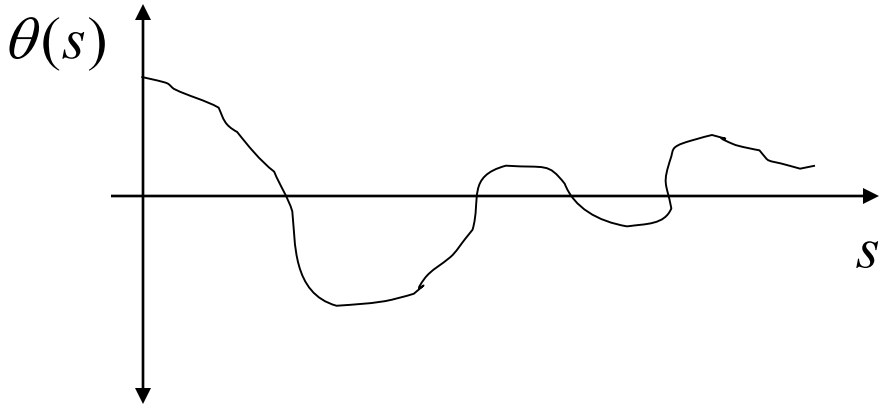

$$U_{Bend} = \frac{EIL}{2}\sum_n q^2\theta^2(q)$$

$$\frac{1}{2}k_BT = \frac{EIL}{2}q^2\left\langle\theta^2(q)\right\rangle$$

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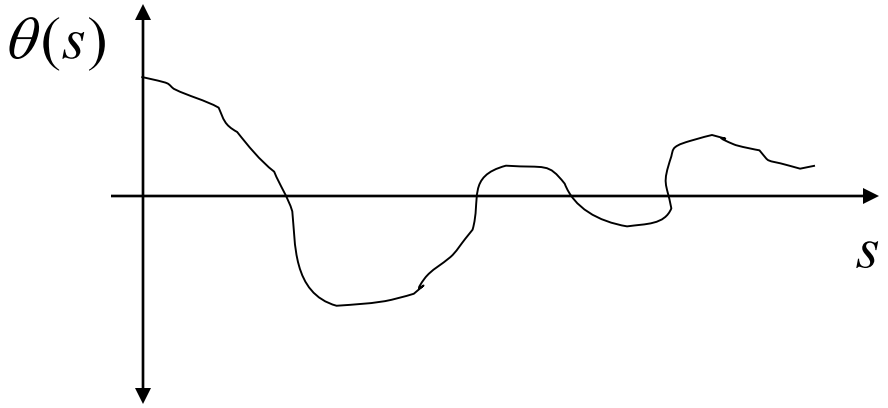

$$U_{Bend} = \frac{EIL}{2}\sum_n q^2\theta^2(q)$$

$$\frac{1}{2}k_BT = \frac{EIL}{2}q^2\left\langle\theta^2(q)\right\rangle \qquad \left\langle\theta^2(q)\right\rangle = \left(\frac{k_BT}{EI}\right)\frac{1}{Lq^2}$$

Bend Energy

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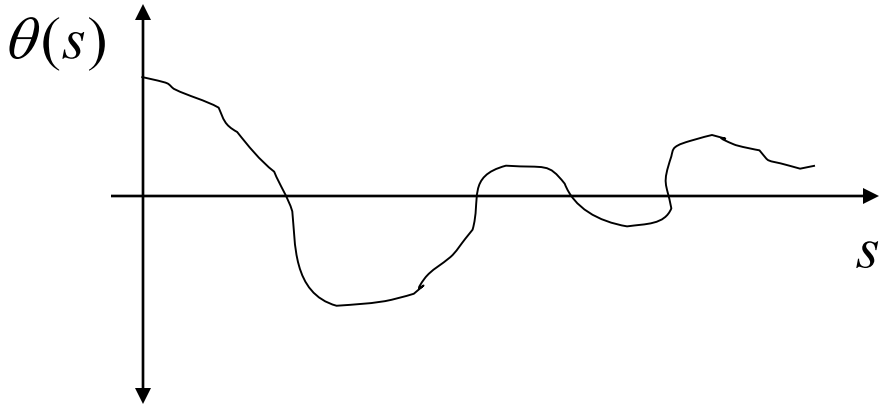

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$$\frac{1}{2}k_BT = \frac{EIL}{2}q^2\left\langle\theta^2(q)\right\rangle$$

$$\left\langle\theta^2(q)\right\rangle = \frac{1}{\xi}\frac{1}{Lq^2}$$

Persistence Length

$$\left\langle \theta^2(q) \right\rangle = \frac{1}{\xi} \frac{1}{Lq^2} \quad \Longrightarrow \quad \xi = \frac{1}{\left\langle \theta^2(q) \right\rangle} \frac{1}{Lq^2}$$

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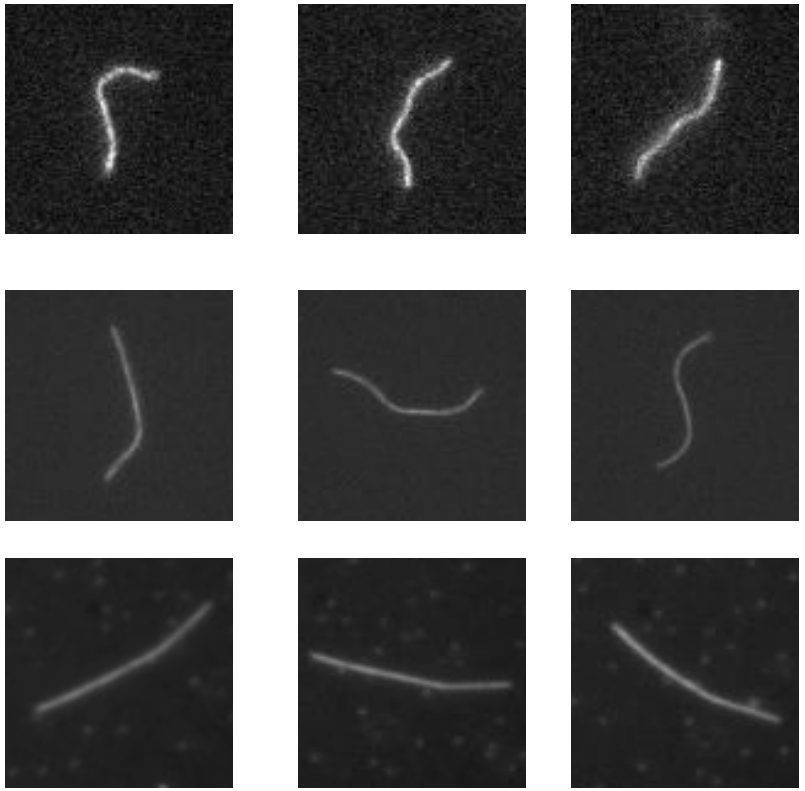

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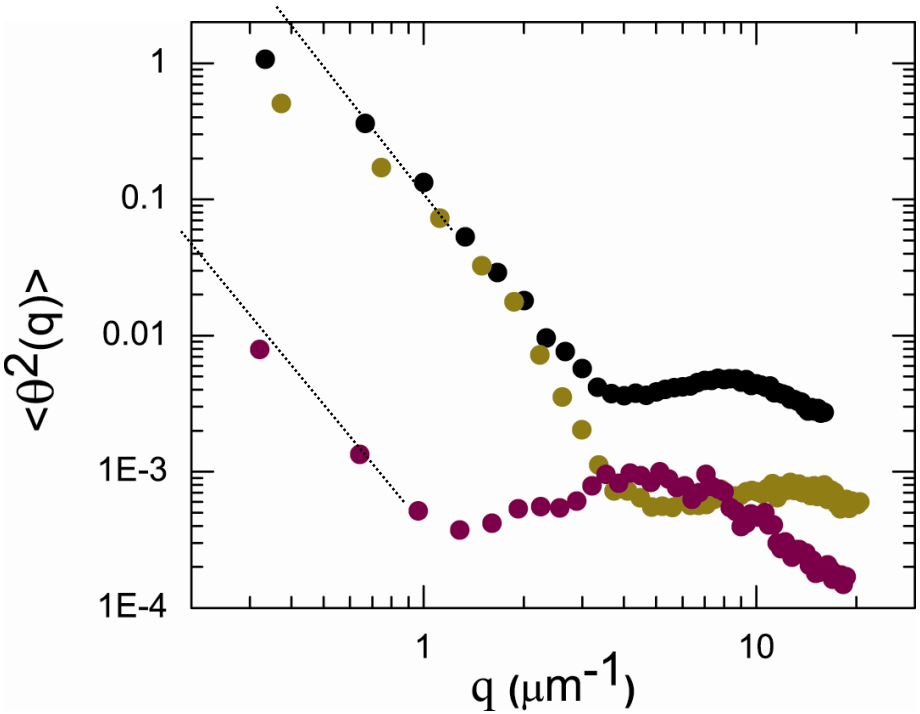

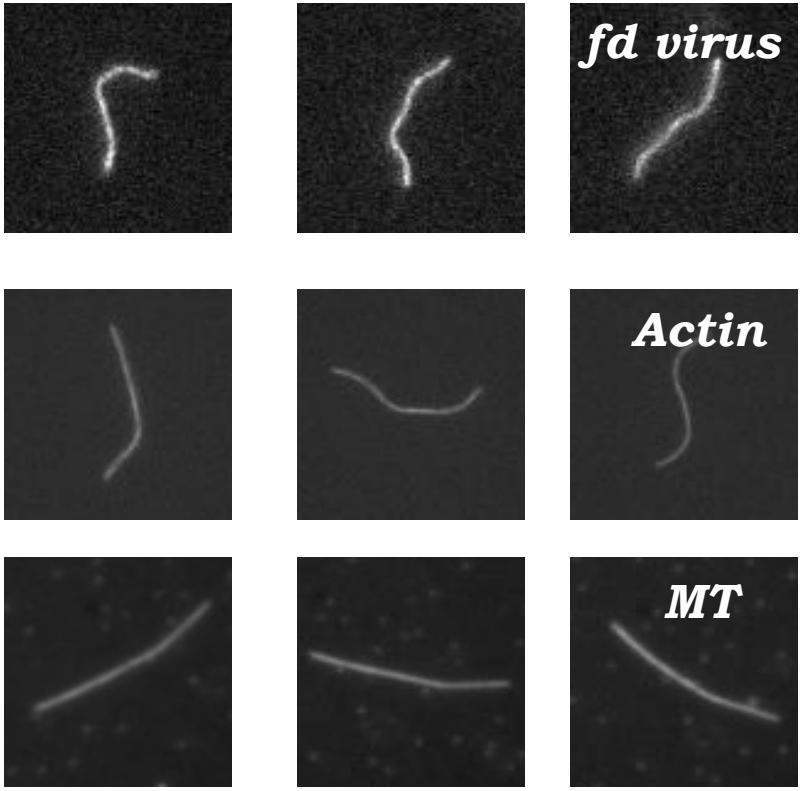

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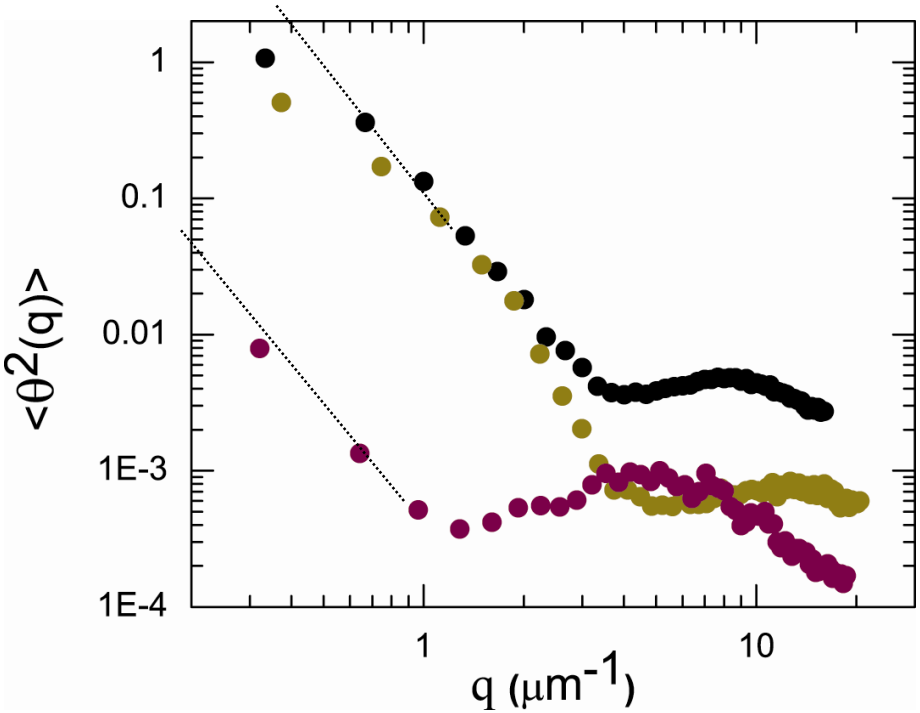

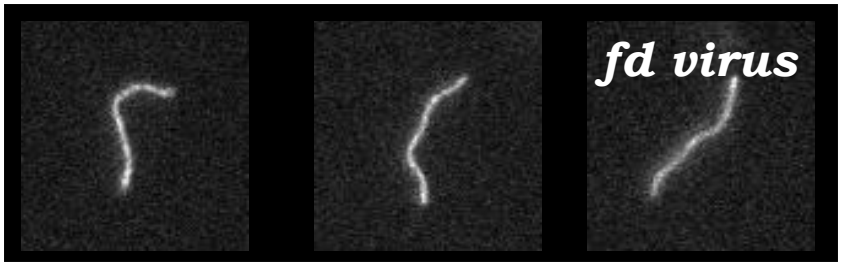

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$$\xi_{fd} = 7.3 \pm 2.1 \mu m$$

$$\xi_{actin} = 13.9 \pm 1.9 \mu m$$

$$\xi_{MT} = 1.6 \pm .0.3 mm$$