TIME-DEPENDENT MECHANICAL RESPONSE OF THE CYTOSKELETON

Nasrin Afzal Michel Pleimling

Department of Physics, Virginia Tech

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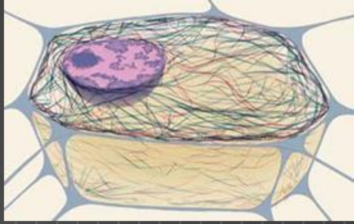
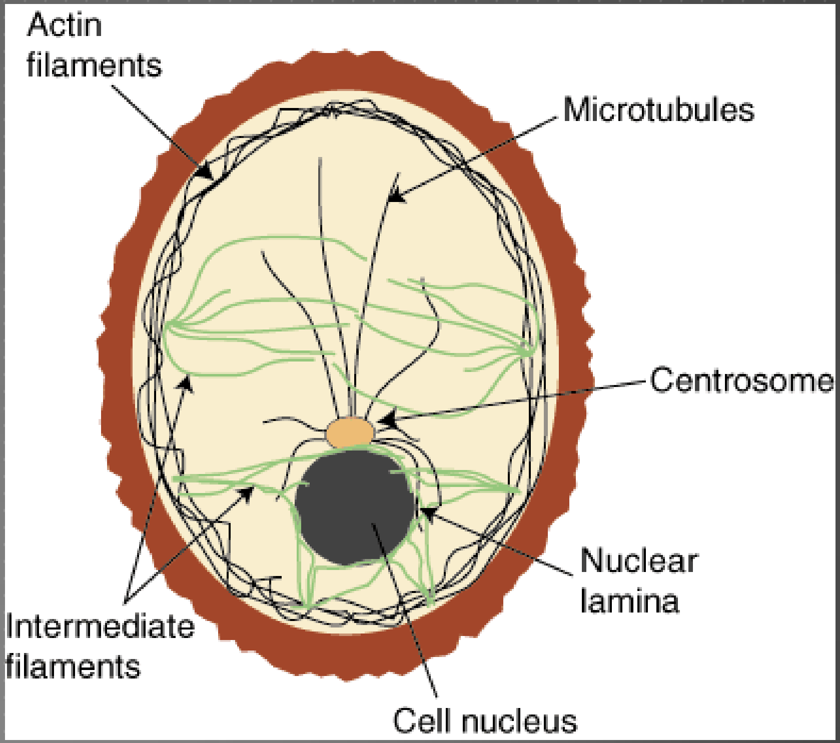
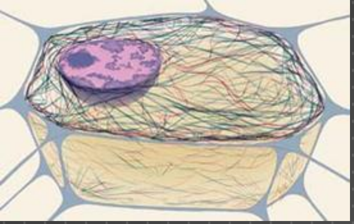
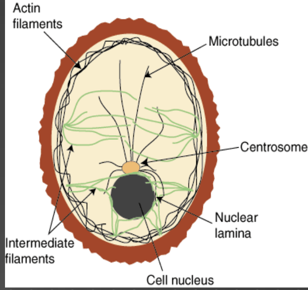


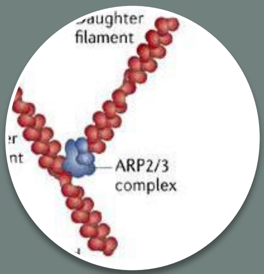
- Cytoskeleton(CSK)
- Motivation
- The Model
- Results



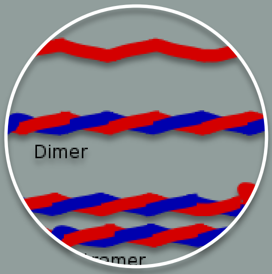


PROPERTIES OF PROTEIN FILAMENTS

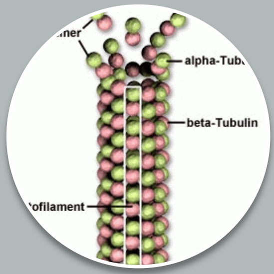




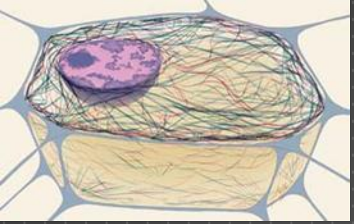
Actin
Diameter=6nm
Pers. Length=3-10μm
Double helix



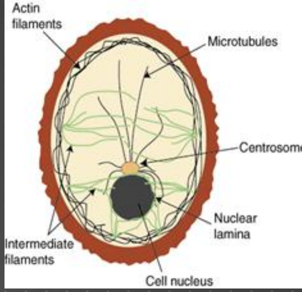
Intermediate filament
Diameter=8-10nm
Pers. Length= 0.3-1μm
2 antiparallel helix



Microtubule
Diameter=23nm
Pers. Length=1-8mm
Hollow cylinder

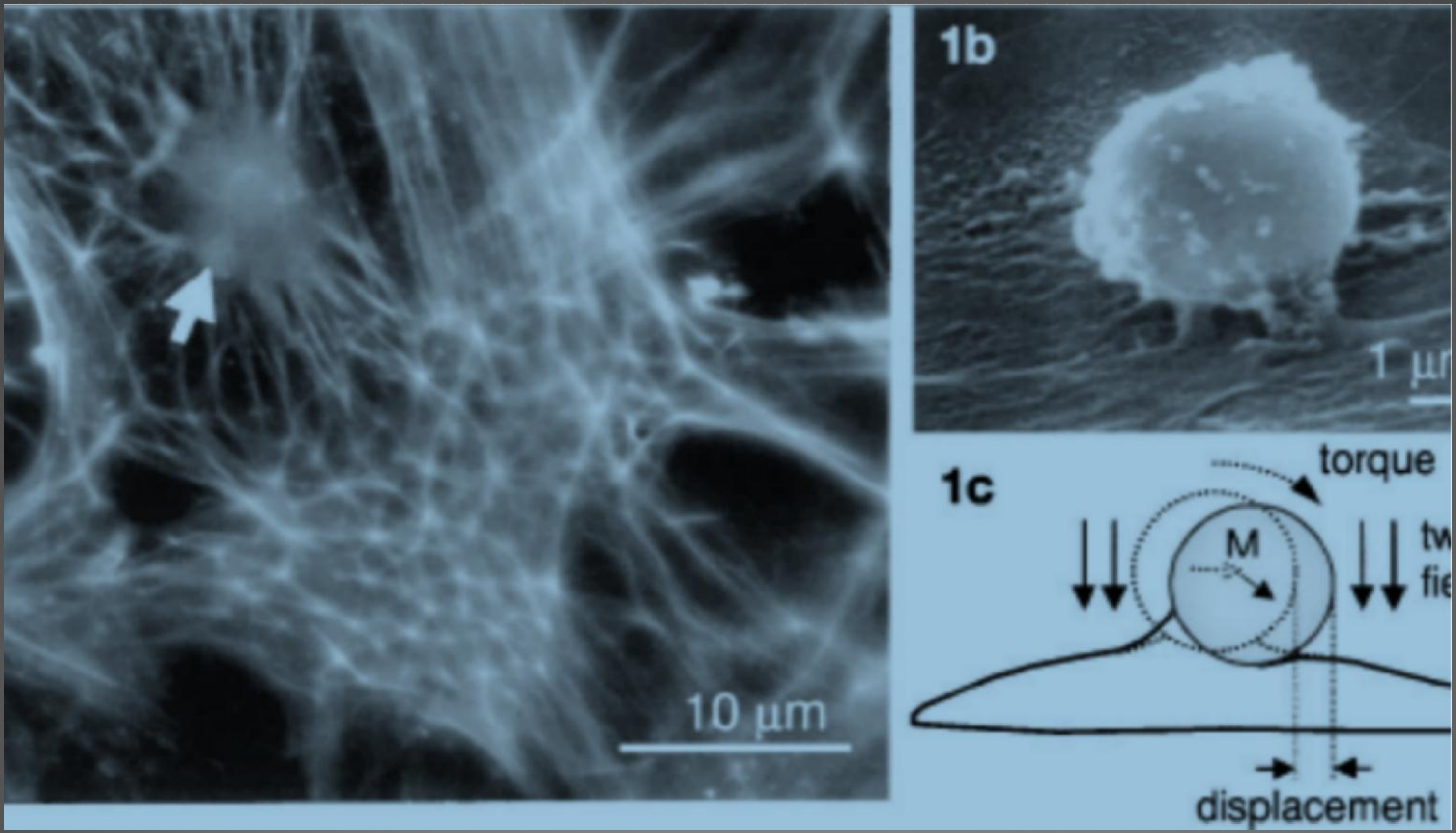


CSK ROLL IN THE CELL

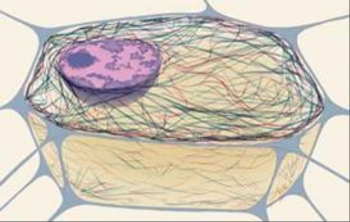


- Establishing cell shape
- Providing mechanical strength
- Locomotion
- Chromosome separation in mitoses and meiosis
- Cellular division
- Intracellular transport of organelles

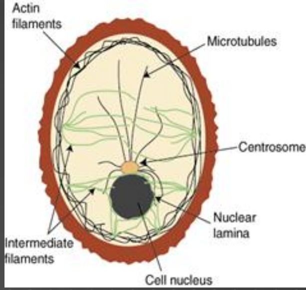
MOTIVATION



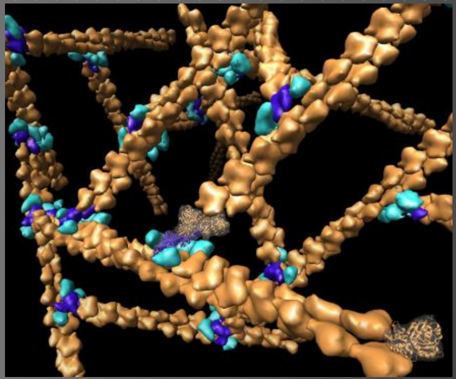
B. Fabry et al,. Phys. Rev. Lett. 87, 148102 (2001)



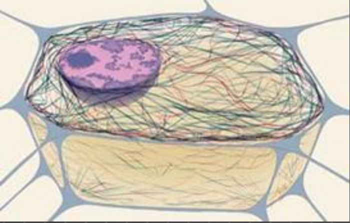
COMPUTATIONAL MODEL



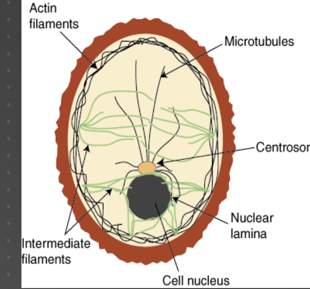
- 3D model of actin network
- Periodic and Free boundary conditions
- Create the network out of equilibrium
- Relax by Monte Carlo movements
- Perturb the cell



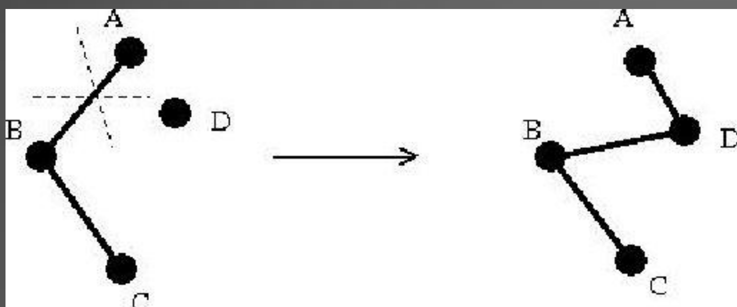
E.M Huisman et al.,Phys. Rev. E 78, 051801 (2008)

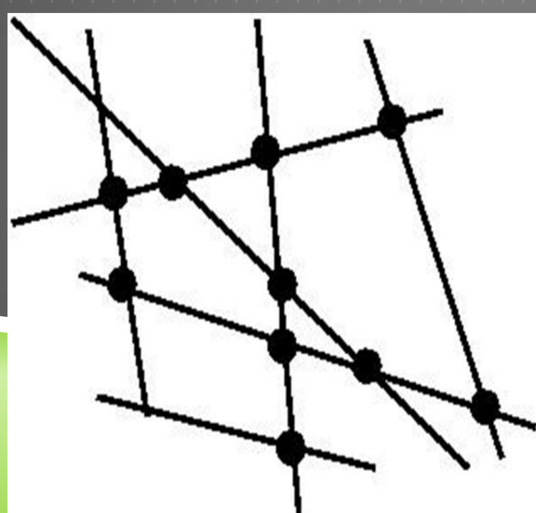


INITIAL STEPS OF THE MODEL

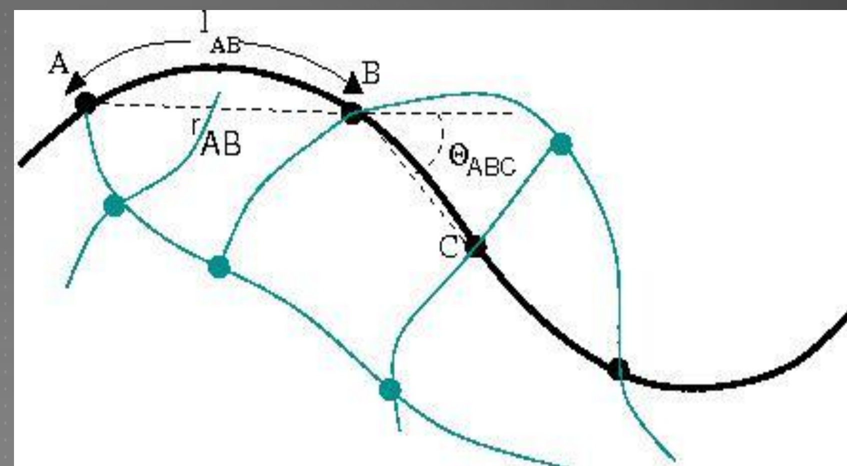


- Creation of four fold connected network

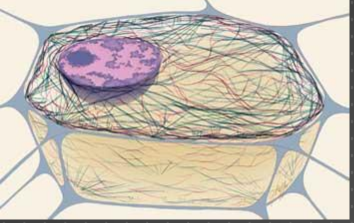




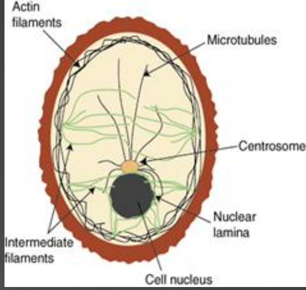
- Assign polymer length for each segment



J. Wilhelm and E. Frey, PRL(**77**) 2581 (1996)



ENERGY OF THE SYSTEM



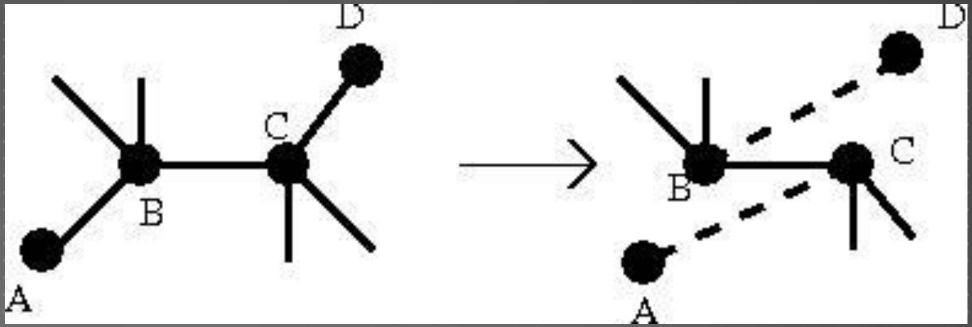
- Energy is sum over all the segments energy,

$$\frac{E}{k_B T} = \sum_i \frac{\mu}{2}\left(r_i - r_{0,i}\right)^2 + \sum_{i,j} \frac{l_p}{l_{c,i}+l_{c,j}} \theta_{i,j}{}^2$$

- μ: Stretching Coefficient
- r_i : End to end length
- $r_{0,i}$: End to end equilibrium length
- l_p: Persistence Length of the filament
- $l_{c,i}$: Polymer length
- $\theta_{i,j}$: Angle between segment i and j

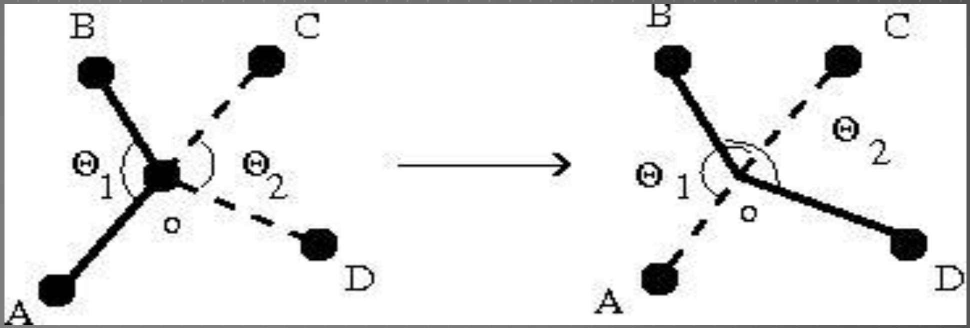
RELAX THE SYSTEM BY MONTE CARLO MOVES

- Rewiring

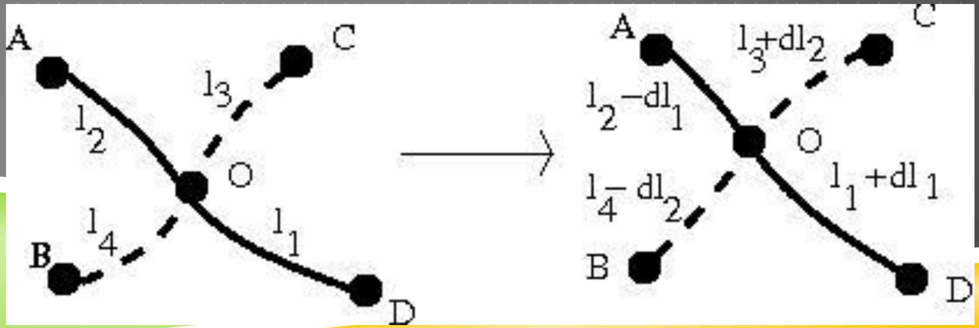


Chop entangled initial filament

- Relabeling

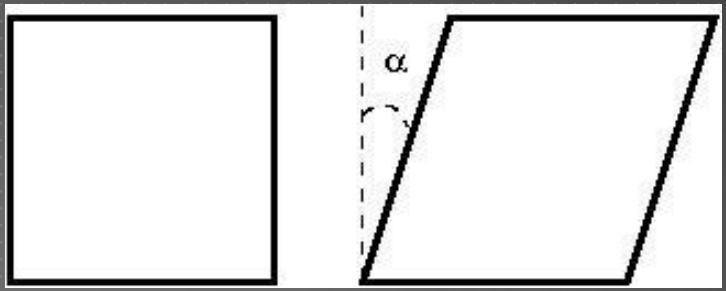


- Shifting Nodes



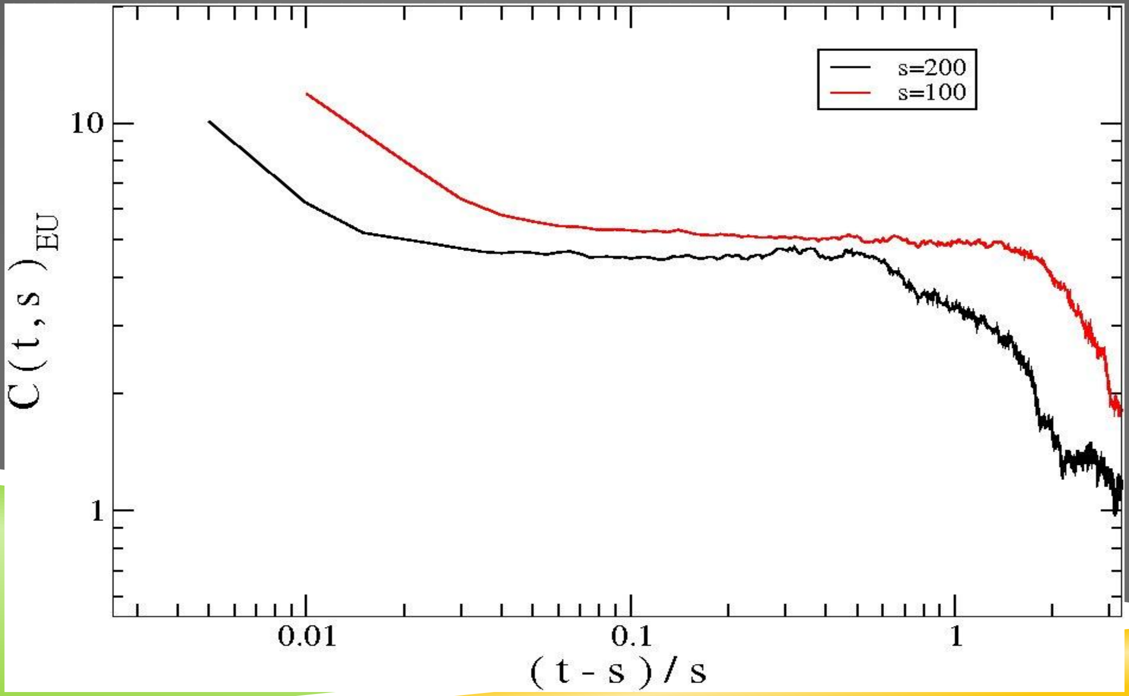
CELL PERTURBATION AND AUTO CORRELATION

- Shear the cell,



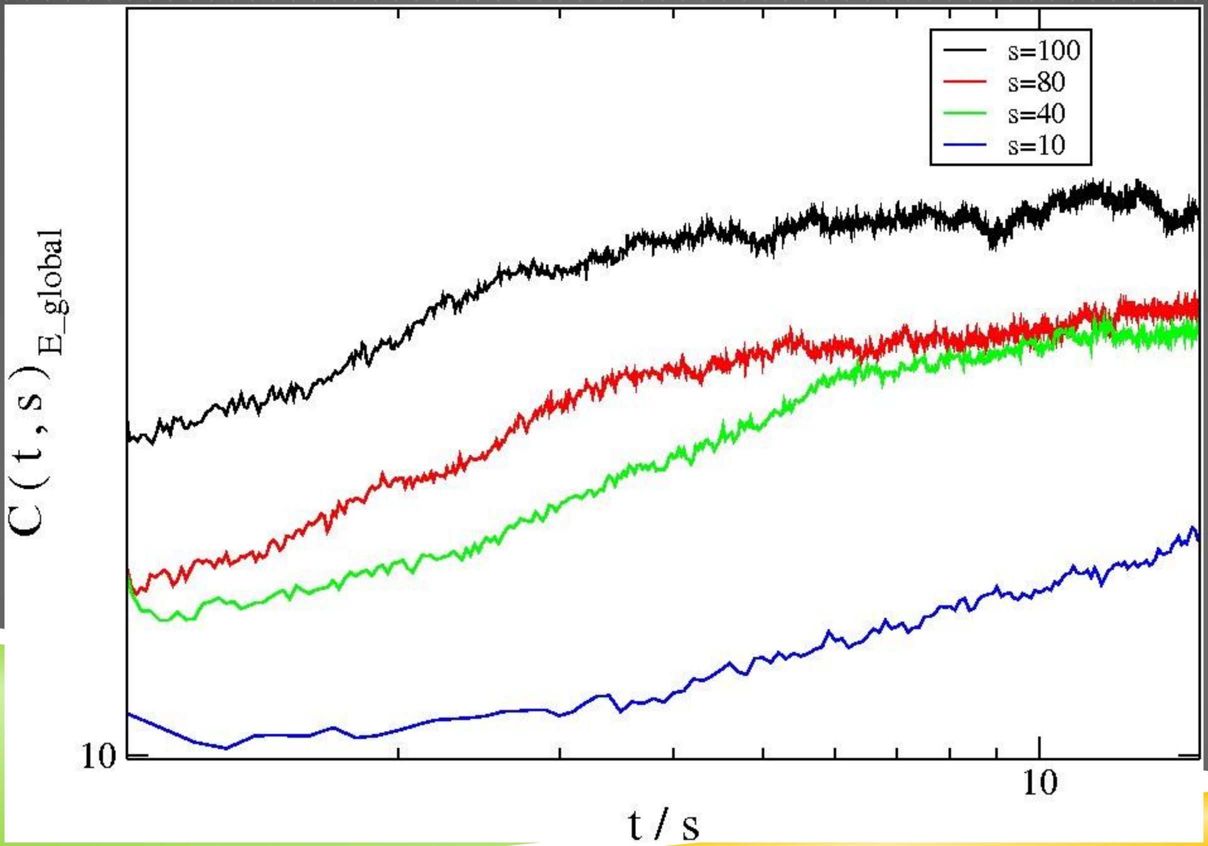
- Two step relaxation

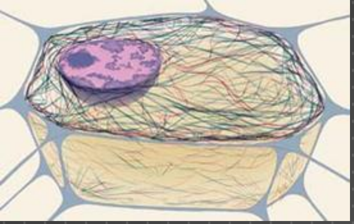
$$C(t,s)_{ED} = \langle L(t)L(s) \rangle - \langle L(t) \rangle \langle L(s) \rangle$$



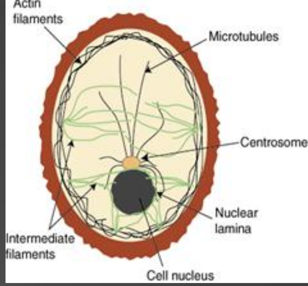
AUTO CORRELATION FUNCTION

- Global Energy
  $C(t,s)_{E_{glob}} = < E(t)\,E(s) > - < E(t) > < E(s) >$





FUTURE PLANS



- Look at the response of the system
- Study the role of the membrane
- Add flexible crosslinks
- Add entanglement points for each segment

Thank You