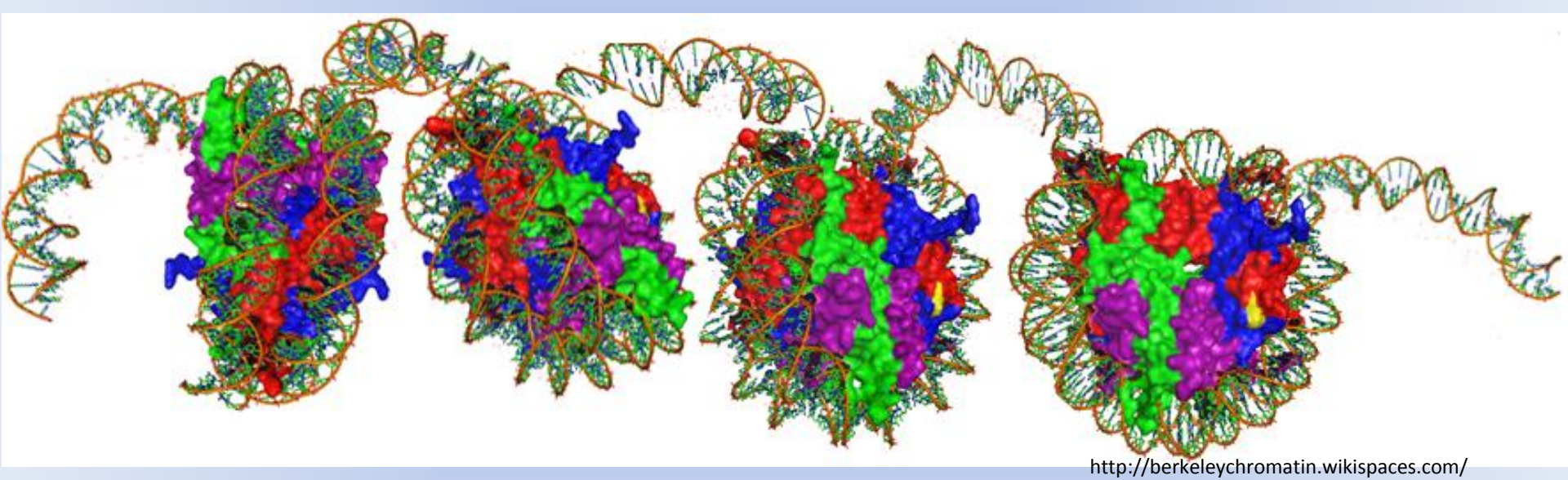
Geometry of Chromatin



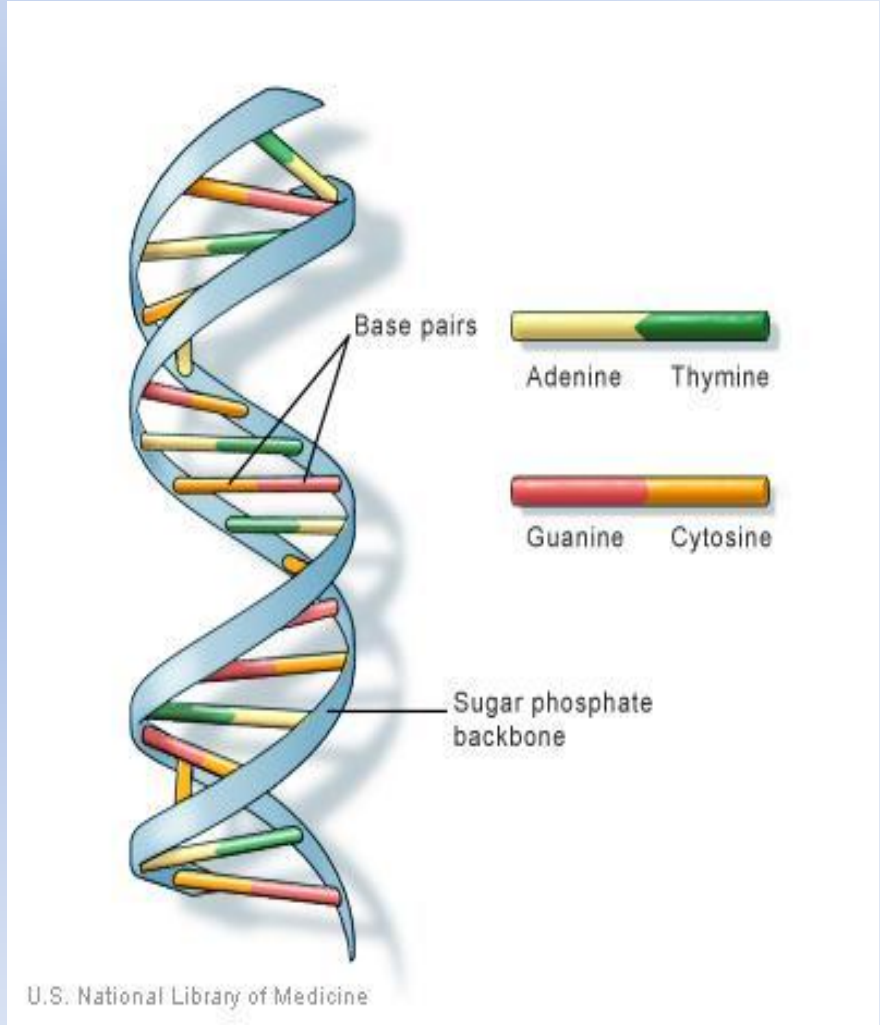
http://berkeleychromatin.wikispaces.com/

Priscilla Lo

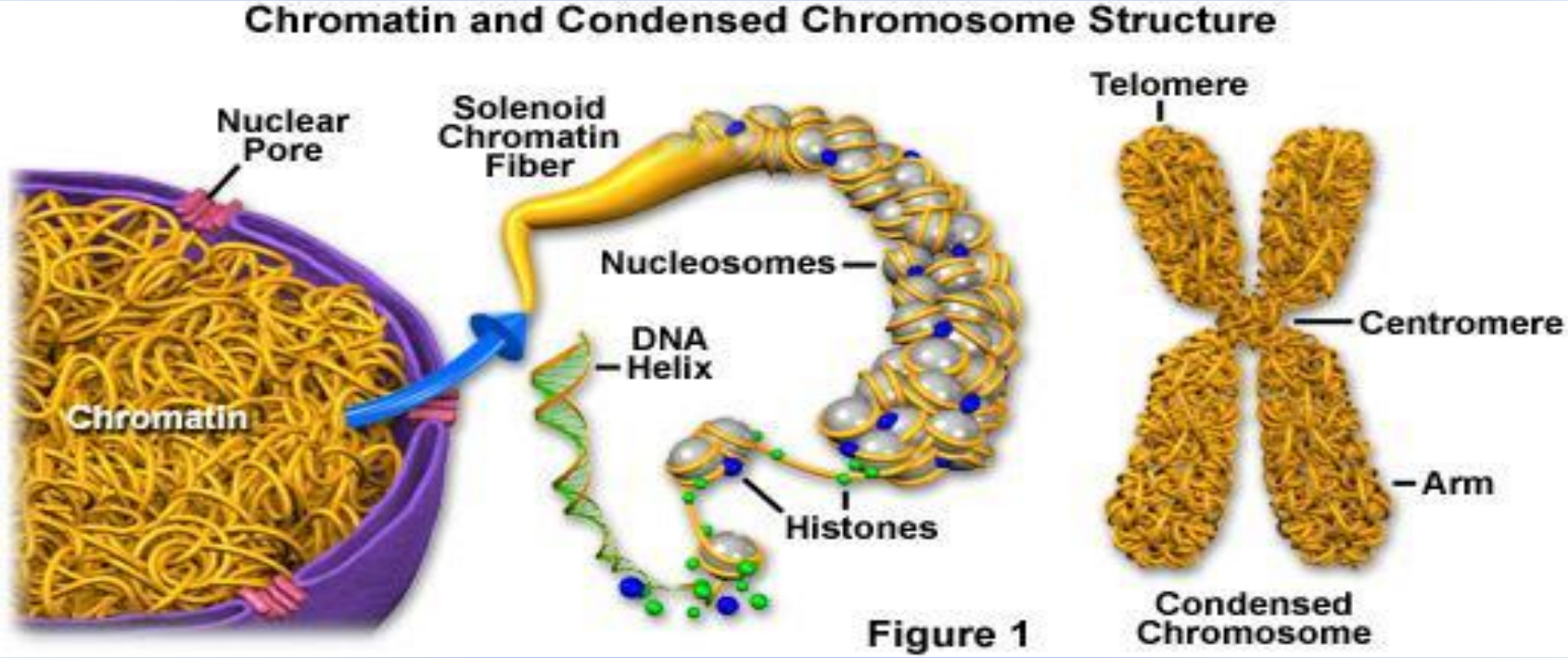
Mentors: Dr. Wilma K. Olson and Nicolas Clauvelin

DNA

- Carrier of genetic information
- Located in cell nucleus
- 2 m long fit into nucleus of diameter 10 microns
- Same DNA in every cell of our body
- Double-Helical structure
  - Backbone
  - Base Pairs



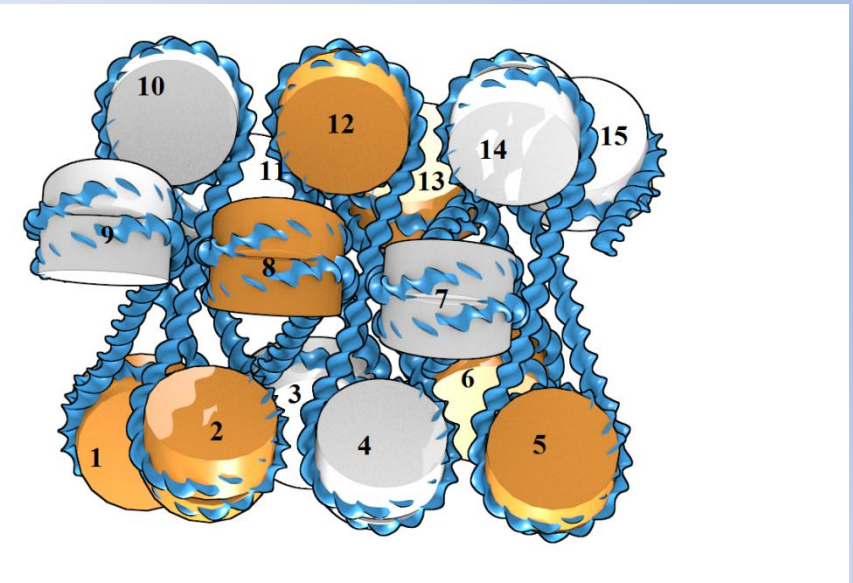
Chromatin



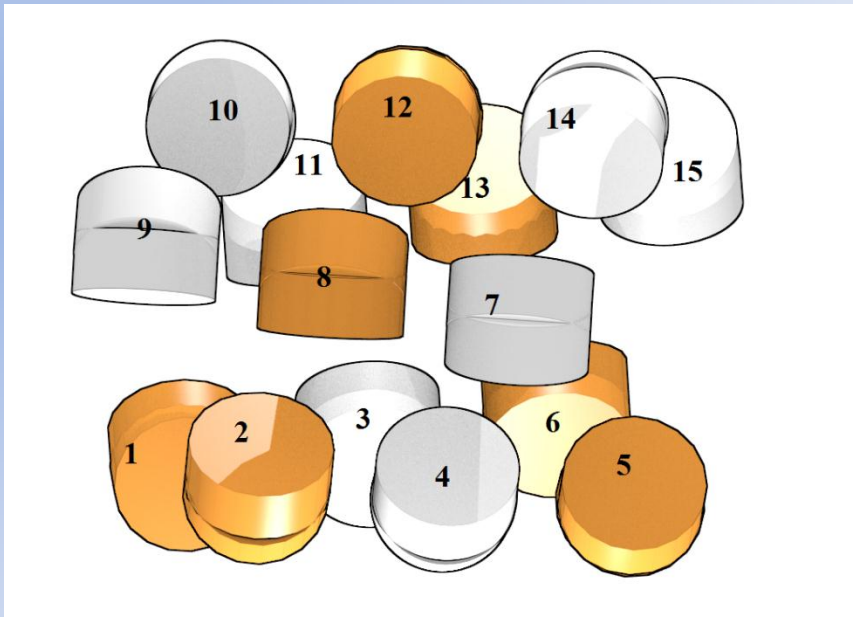
- Chromatin = DNA + histones (and other proteins)
- 8 histones make an octamer core
- DNA wraps around the octamer core (roughly 150-bp) to form a nucleosome core particle

Geometry of Chromatin

Nucleosomes + Linker DNA



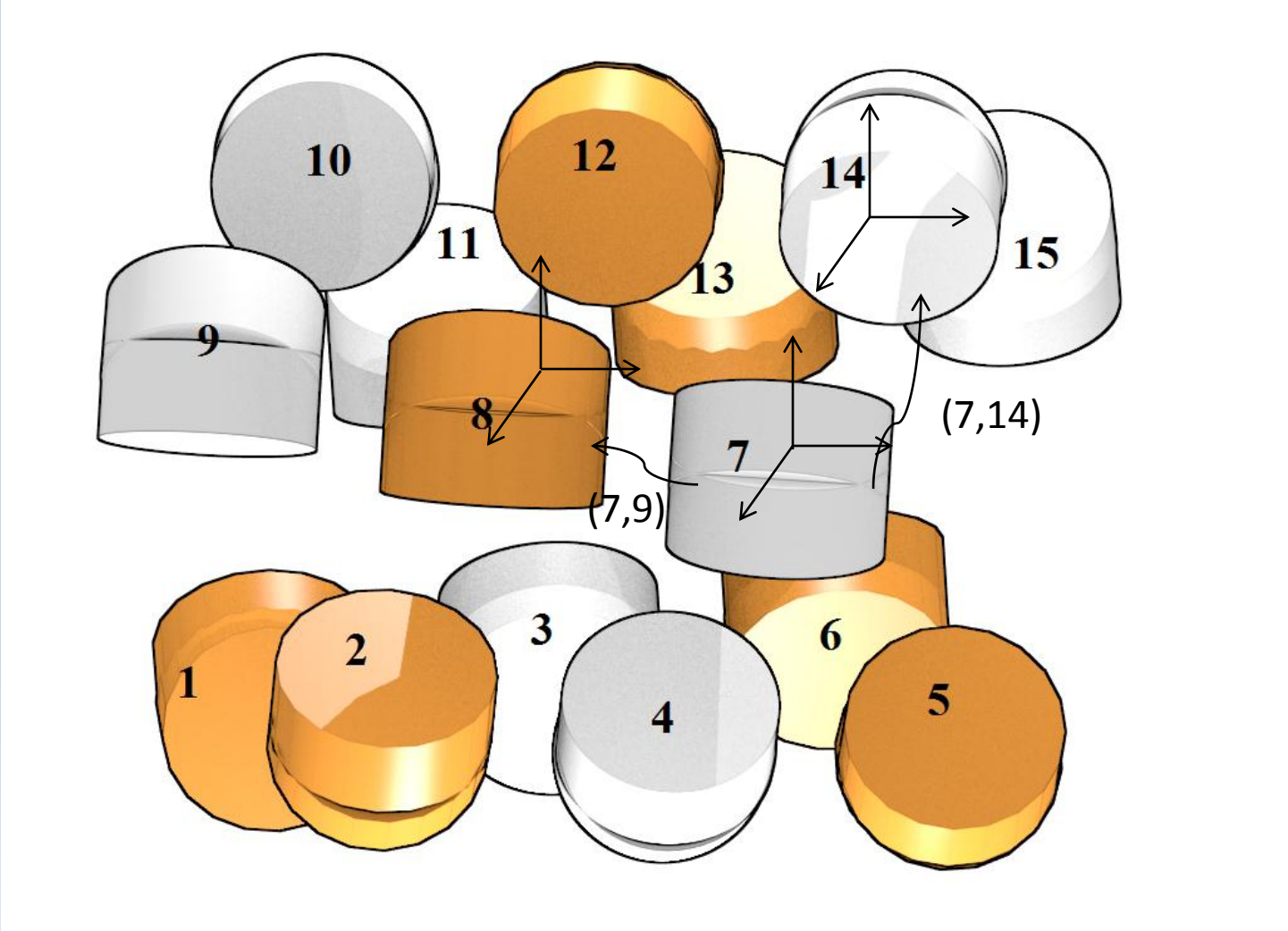
Nucleosomes Only



Project : Looked at the interaction between nucleosome pairs only

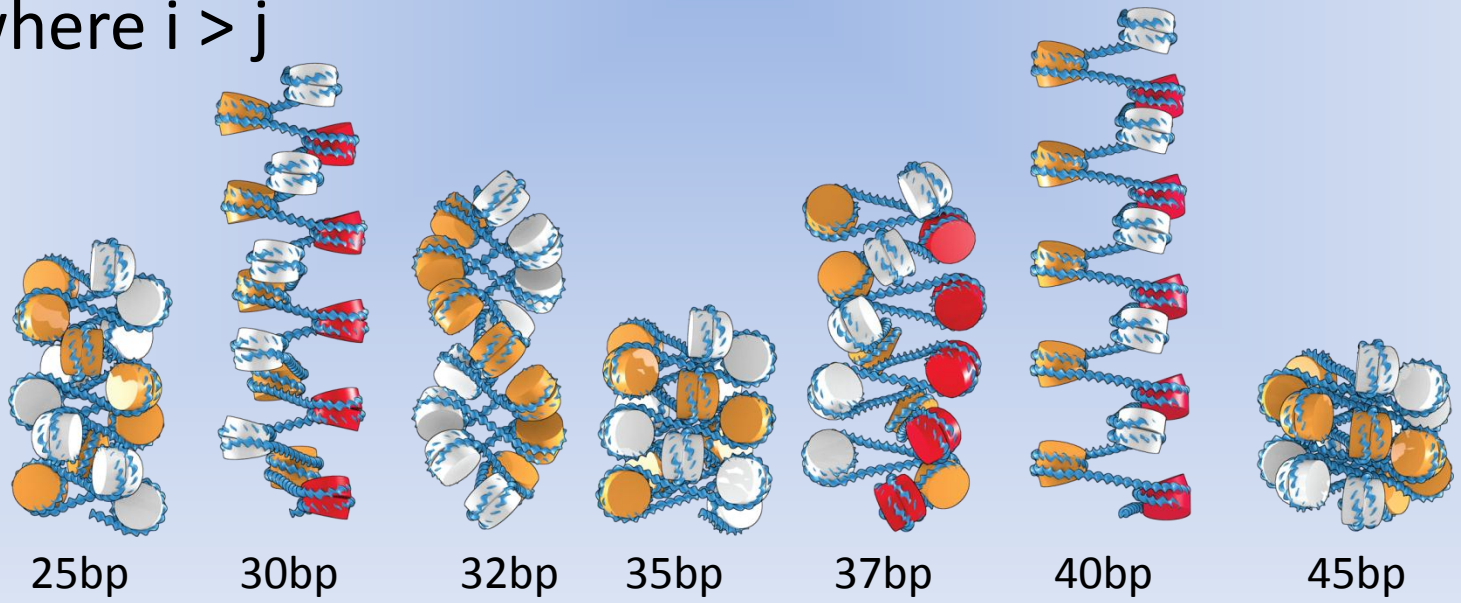
Geometry of Chromatin

- Viewed at a nucleosome level as rigid bodies
- Ex.



Data

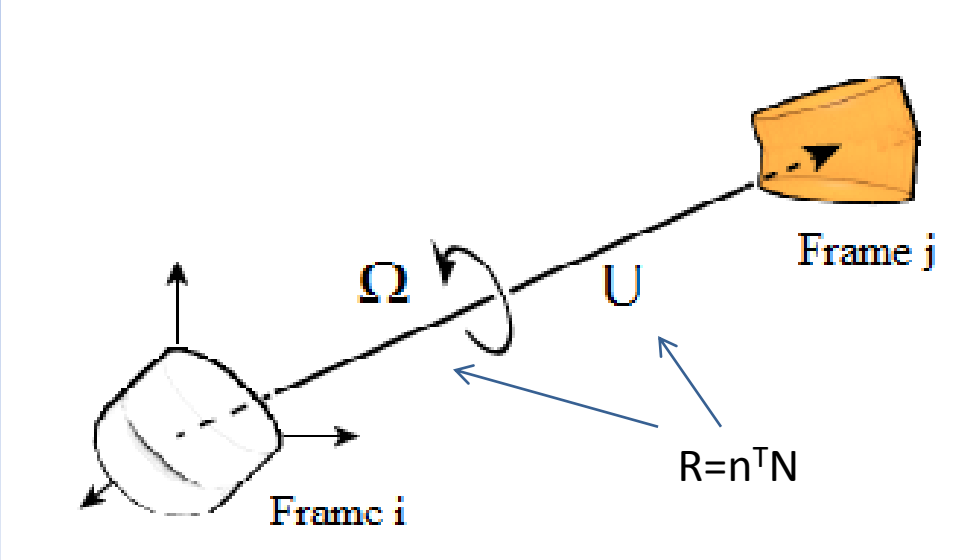
- Simulations of chromatin for different DNA linker lengths
- Each configuration had 11 nucleosomes
- Consider each pair (i , j) of nucleosome frames where i > j



Rotation

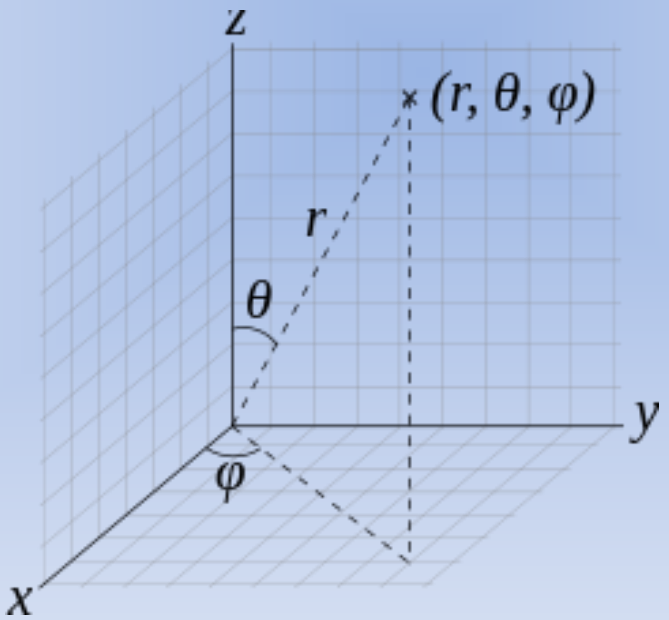
- Describe for a nucleosome pair (i,j) the rotation between nucleosome i and nucleosome j
- Axis of Rotation U and Angle of Rotation Ω
- From axis of rotation U obtain spherical coordinates

  α and β
  - $(z \cdot U) = \|z\|\|U\|cos\alpha$
  - $\beta = ArcTan(sin\beta/cos\beta)\ ; cos\beta = (x\ \cdot v)/\|v\|; cos\beta = (x\ \cdot v)/\|v\|$



Translation

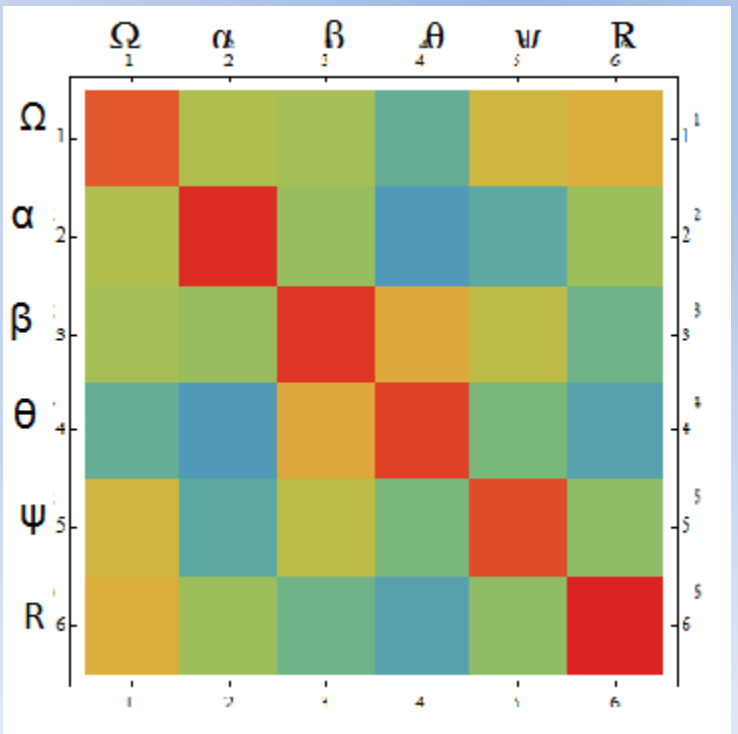
- Vector between origins of nucleosome frames
- $D=n^T \cdot \{x_j-x_i, y_j-y_i, z_j-z_i\} = \{R_1, R_2, R_3\}$
- Spherical coordinates - θ and ψ



http://en.wikipedia.org/wiki/Spherical_coordinates

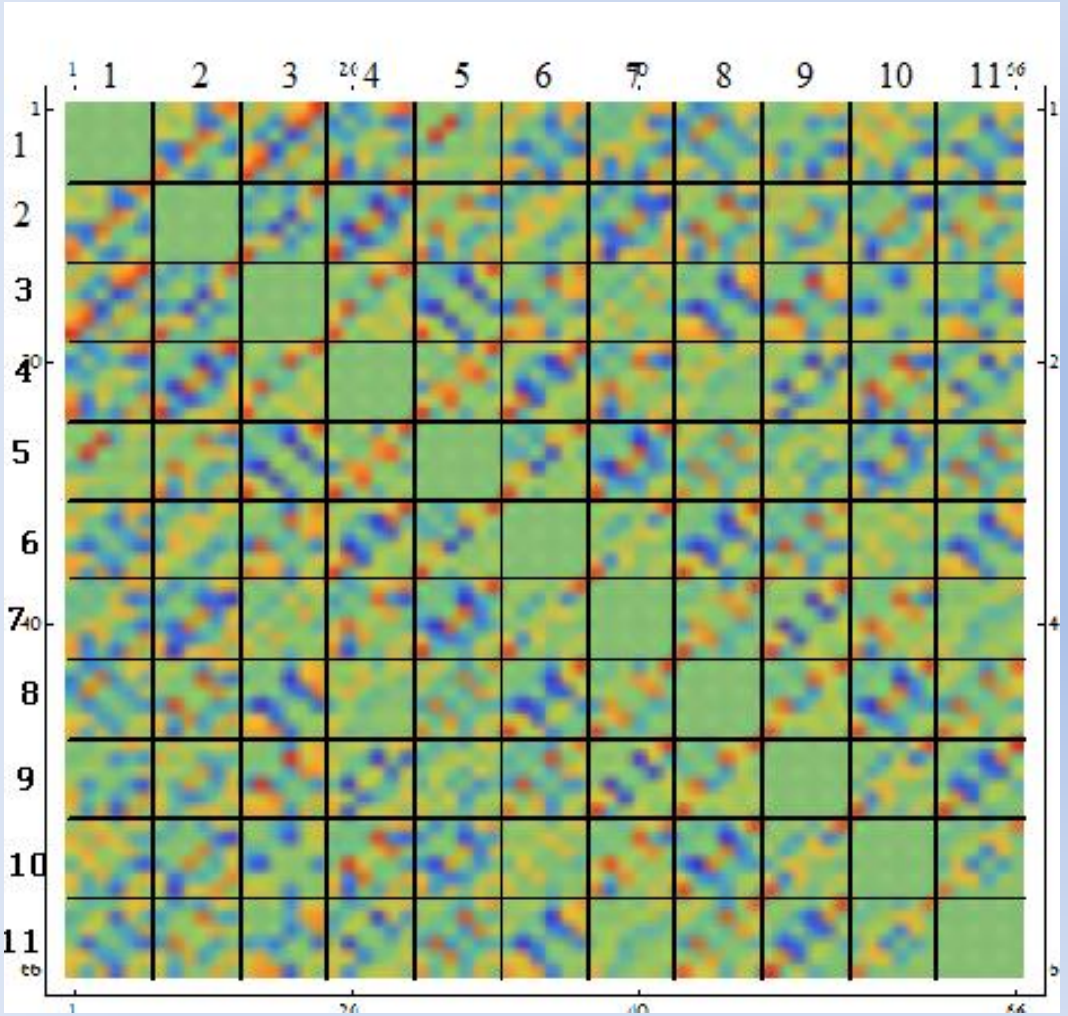
Parameters

- $p^i = < \Omega^i , \alpha^i , \beta^i, \theta^i, \psi^i, R^i >$
- $\delta p^{*i} = p^{*i} - < p^* >$
- From parameters, correlation can be obtained by multiplying mean of parameters from all configurations by its transpose



15bp linker DNA
Pair (1,2)

Chromatin Fiber Correlation Matrix



15bp linker DNA

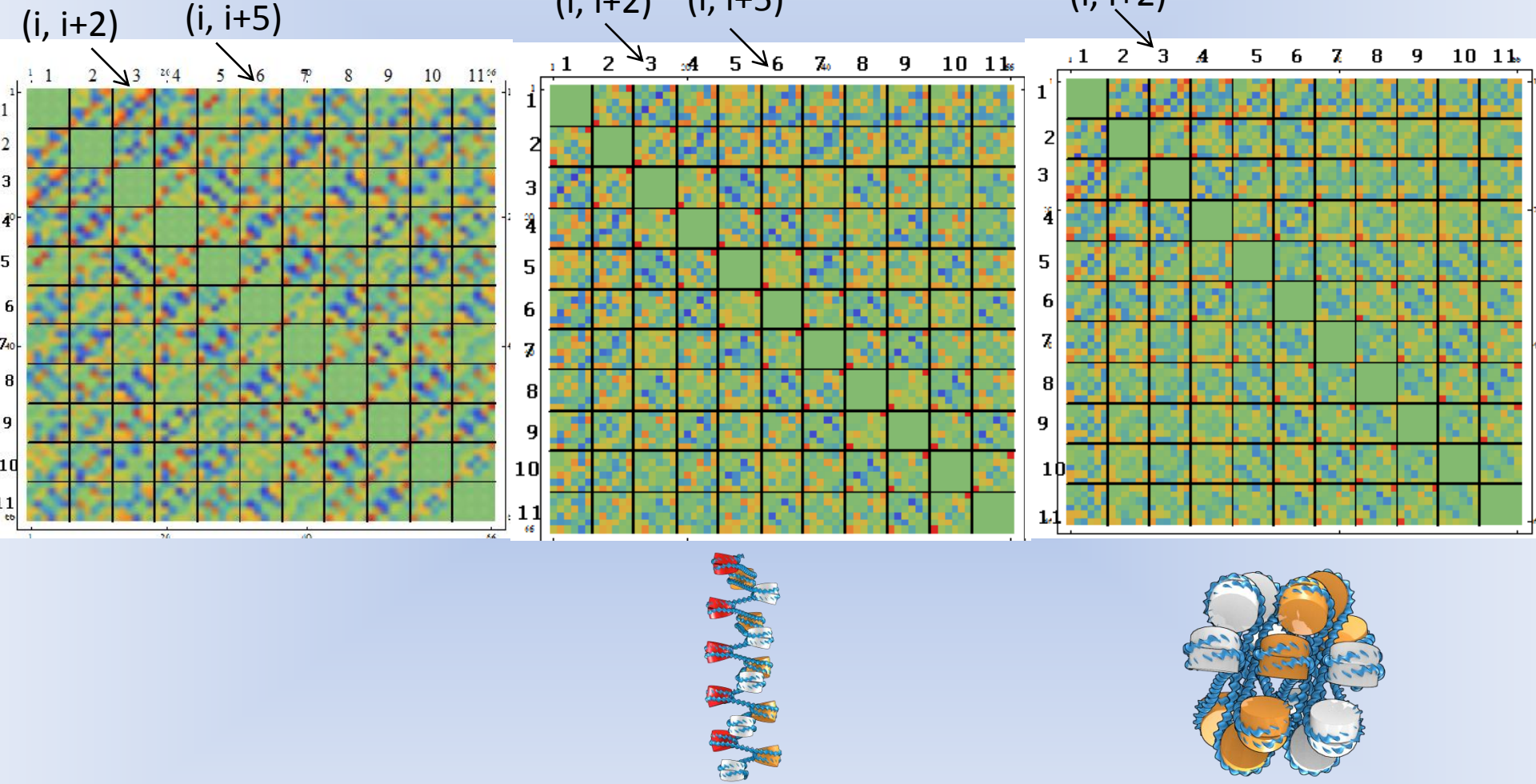
- Build correlation matrix for full chromatin fiber
- Each square is 6x6 correlation matrix of the pair (i,j)

Comparison of Chromatin Fiber Correlation Matrix

15bp linker length

30bp linker length

45bp linker length



Conclusion

- Model chromatin from a geometric point of view
- Use of matrices to analyze patterns between pairs of nucleosomes