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Chromatin State-Dependent Polymer Model: Bridging Nucleosome Positioning and Large-Scale Chromatin Organization

Chromatin organization plays a crucial role in regulating genome accessibility and nuclear processes. My research focuses on nucleosome positioning and chromatin accessibility, extending polymer physics models to incorporate state-dependent chromatin properties. The structural and dynamic behavior of chromatin—such as bending rigidity, compaction, and accessibility—is modulated by biochemical modifications, including histone acetylation and protein binding (e.g., H1, PRC1, HP1).

To capture these effects, I integrate fine-scale molecular dynamics simulations of nucleosomal arrays with coarse-grained polymer models, linking local chromatin mechanics to genome-wide organization. This approach enables us to explore how heterochromatin and euchromatin domains influence nuclear architecture, impacting transcription factor binding, chromatin remodeling, and phase separation.

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