Report: Characteristics of pinned polymer loop in external field

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1 Motivation

During meiosis I in Fission Yeast (S. pombe), a dramatic chromosome movement named nuclear oscillation is observed. Spindle Pole Body (SPB), which is a centrosome like organelle embedded in the nucleus membrane and bonded to the microtubes out of nucleus, drives the nucleus moves forward and backward in the cylinder shaped cell. Chromosomes in the nucleus, which are of course moving together, are aligned and recombined during this $2-3$ hours period.

Chromosomes with both ends bound to SPB can be modelled by polymer loops. Consider the time window of one-direction moving of nucleus, hydrodynamical interaction between cytoplasm and chromosomes acts as an external force field on every spot of the loop. Transform to a co-moving frame (sitting on the SPB), the movement of chromosomes in one direction maps to the scenario of pinned polymer loops in external force field. Since the moving speed of nucleus in one direction is nearly steady (observed in experiments), the corresponding force field can be considered as constant.

There are three pairs of homologous in fission yeast nucleus. Morphology state of these chromosomes are believed to be important to biological functionalities such as recombination. We therefore want to study the characteristics of these chromosomes during nuclear oscillation. More specifically, I assume the shape of the nucleus is determined by the morphology of chromosomes (to be justified). With this assumption, it is possible to compare the prediction to experiments. Using both theoretical and simulation tools, several characteristic parameters of polymer loops in external force field can be calculated quantitatively.

2 Model

Pinned polymer loops in external force field is used to describe chromosomes. As shown in Figure 1. The

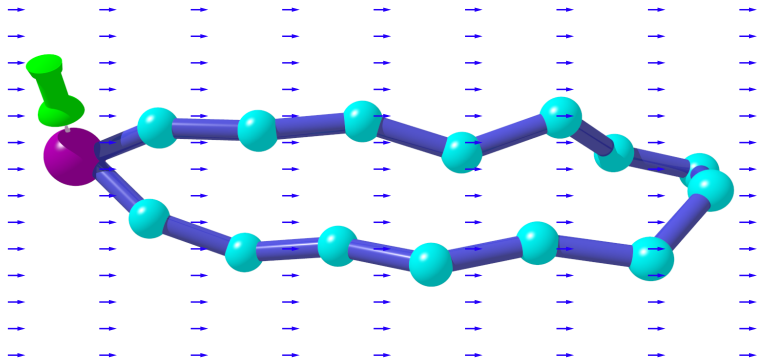

Figure 1: Sketch of polymer loop representing chromosomes. Magenta bead represents the SPB.

3 Simulation

4 Results

5 Discussion